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GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.
N. H. WINCHELL, State Geologist.

BULLETIN No. 7.

THE

MAMMALS OF MINNESOTA.

A SCIENTIFIC AND POPULAR ACCOUNT OF THEIR FEATURES AND HABITS,

WITH

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THE MAMMALS OF MINNESOTA.

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CORRIGENDA.

Page 17, ninth line from bottom, for "Monotremata" read Monodelphia.

Page 18, seventh line, for "Monotremata" read Monodelphia.

Page 48, preceding Sorex cooperi, insert

GENUS SOREX.

Smallest mammals with soft and short pelage. Both feet with five digits. Teeth free. Body mouse-like, with elongated head and projecting snout, closely appresed valve-like ears concealed beneath the fur, and cylindrical or four-angled tail (covered with annular scales and hairs), which is longer than the body. Soles naked. Claws not retractile. Special glands near the fore legs. Eyes small. Dentary formula: I. $\frac{3}{2}$, C. $\frac{0\text{-}0}{0\text{-}2}$, P. M. $\frac{5\text{-}5}{2\text{-}2}$, M. $\frac{4\text{-}4}{3\text{-}3}$, = 32. The incisors have toothed edges and an accessory basal hook. All the teeth are white with brownish tips.

Page 48, sixth line from the bottom, insert

Color, above grayish brown; entire under parts including tail silvery. Easily distinguished from other Minnesota species by the size and length of tail.

Page 78, sixteenth line, dele "PLATE VI."

Page 102, nineteenth line, for "Putoris" read Putorius.

Page 108, under Ermine or White Weasel, for "Plate XV" read Fig. 8 A, p. 107.

Page 158, under Fox Squirrel, dele "Plate VIII," and at the bottom of the page the note referring to the same.

Page 159, under Sciuropterus volucella, dele "Plate VII."

Page 162, under Rocky Mountain Chipmunk, dele "Plate IX."

Page 223, after COMMON POCKET GOPHER, insert

Frontispiece.

NOTE.—As originally prepared it was intended that the following work should be illustrated by a number of other plates, the greater part of them colored lithographs. On account of the cost of such plates many of them were rejected at once, and more recently again the Printing Commission decided to publish, with the exception of Geomys bursarius, only those which were suitable for reproduction by the photo-engraving and half-tone processes. Unfortunately the proof-reader failed to notice, until over half the pages had been printed, that the corresponding changes had not been made in the manuscript by erasing the references to omitted plates, and to this oversight is due the irregular numbering of the plates and the fact that some of the descriptions call for plates that are not included.

N. H. W.

PREFACE.

The manuscript and plates for a final report upon the mammals of Minnesota were turned over to the Survey in 1885, with the expectation that the work would be speedily issued as part of a quarto volume of the series of final reports. Circumstances with which the writer is unacquainted have delayed the publication over six years and in the meantime much work has been done in all branches of biology, and the state has been carefully surveyed by the United States agents. Much of whatever may have had any value as an original contribution to science has lapsed and much of the remainder has been rendered unnecessary by recent publication. This is especially true of bibliographical material. When, however, the publication was finally ordered and no opportunity was afforded for further field work, it seemed best to adapt the manuscript for the purpose by the omission of much which could not be edited satisfactorily under the circumstances, and, separating the more general from the technical portions, to issue these in the form of two bulletins, uniform with the series already established by the Survey.

The present installment, therefore, contains the descriptive and popular portion, with such illustrations as may serve to assist the amateur. The second part will be devoted to the materials collected upon the anatomy, especially the myology and osteology of the mammals of Minnesota.

July, 1891. C. L. HERRICK,

Univ. of Cincinnati.

INTRODUCTION.

The present volume is intended to serve a double purpose. The comprehensive nature of the law authorizing the Natural History Survey of the state might lead the reader to expect much more than the limited time and means at our disposal made possible. This report, therefore, while putting in permanent form such data as came to hand during the few months occupied in its preparation, will best serve its purpose if it indicates in a general way the kind of observations and records, the nature of the problems and the method of investigation desirable for the future work in this department within the state. The greatest barrier in the way of the preparation of this report was the almost absolute absence of anything like scientific interest in zoology in the state. There were no reliable data available, nor were there persons prepared to collect such data intelligently. It is a matter of congratulation that a permanent bureau has been established in connection with the University for the prosecution of such studies as naturally fall to the lot of a Natural History Survey, and the general dissemination of the scientific spirit and attainments may yet make it possible to preserve the records of the natural biological phenomena of Minnesota, now rapidly being obliterated by the changed conditions accompanying the encroachments of civilization.

As a compensation for this loss, however, a not less interesting set of problems growing out of the adjustment of the native population to the incoming one presents itself, and these questions have a theoretical as well as practical significance difficult to over-estimate.

Of course the collection and description of all the species of mammalia still existing in the state is an obvious duty in connection with the preparation of such a report. The omissions and errors which of necessity exist in the present essay will soon doubtless be made good by the activity of the Mammalian Branch of the Agricultural Department, U. S. A., under the direction of Dr. C. Hart Merriam.

Any clear understanding of the present fauna implies a study of the record of its development as supplied by paleontology. It is also desirable to learn what influences have acted to cause the extinction of some animals, to change the habitats of others, and to modify the form and habits of still others. An obvious duty is the study of the habits of our mammals, such especially as relate to the food and economic relations. Some animals rank among the most important enemies of the farmer and poultryman, while others are either indifferent or are worthy of preservation for the contributions they make to the resources of parts of the state. There are regions which nature seems to have designed as natural game preserves and suitable legislation might long continue to us the opportunity for healthful sport, and pleasant variety in the food supply. The facts relating to the fur trade are also legitimate to this work and some account of the methods pursued in collecting the furs, so necessary an adjunct to winter clothing, would certainly not be out of place. If any incidents could be intermingled which would either reflect light on the habits or excite popular interest in a neglected branch of science these certainly are admissible. A scientific study of our mammals would involve much more than this. Aside from intricate questions which arise as to the actual limits of species and relative value of varietal characters the anatomy and physiology of each mammal furnishes a field for exhaustive study. An adequate knowledge of the relationships existing between the various living as well as fossil animals, must be founded upon an intimate familiarity with the points of similarity and dissimilarity in their internal structure. The complete study of the anatomy of a single animal is the work of years, so that here is a field which one person would scarcely hope to cursorily examine, much less to exhaust.

In a state as large as Minnesota there are abundant opportunities for the study of the influence of environment upon the anatomical and physiological peculiarities of the fauna. Probably no other state in the Union is so favorably situated for this study. In the northeastern part of the state is an area with an annual rainfall almost as large as anywhere in the Union. The western portion borders upon the great prairie region of the interior. The northern portion of the state contains a large invasion of the boreal fauna, while the southern receives waifs from the south-central states. Moreover, the distribution of forest and plain is such as to introduce diversity

of station within those habitats. Although there are no alpine or strictly mountainous regions in the state the diversity of surface and soil is considerable. The vast number of glacial pools carries the habitat of the musk rat far into the prairie belt. The prevalence of coniferous trees in the northern part of the state exerts a very pronounced influence upon its fauna. The opportunity to study the gradual changes in the same species as it crosses the imperceptible but most real boundary separating these several habitats is of the greatest value for a comprehension of the bearing of evolution and the proper definition of a "species."

Another field for investigation is not less interesting than the above mentioned. The language of a people, and especially of a rude people, is influenced to a high degree by the external objects which furnish the mind with the earliest conceptions and the tongue with the first-framed words. Animated nature, and especially those animals whose large size and close relations with the individual naturally excite interest, have a large share of influence. The psychologist is interested to know what phases of animal-life have made the most vivid impression upon different tribes and to thus read the temperament and mental endowment of aboriginal people in their language. The philologist studies with no less interest, although from a different stand-point, the effect of animals upon the various languages. If the prominent beasts of prey have identical or similar names in distant tribes, he seeks to discover whether consanguinity or previous accidental propinquity was the occasion.

Archæology has by similar means succeeded in forming a vivid picture of the domestic life of early European times, while in this country little attention has as yet been directed to the subject.

The effects of external objects upon the human mind are seen in pictorial representations almost as soon as in vocal imitations of properties possessed by them or verbal signs for them. The picture writing of the savage is most highly interesting not only as furnishing information regarding his own method of life but of the previous range of extinct animals or such as have since migrated. In this way the contemporaneous existence of man and the mammoth has been proven in Europe, and genuine and well authenticated aboriginal carvings should be carefully collected and studied, as well by the biologist as the archæologist. Among the ancients various animal as well as

human figures were used in art to a much greater extent than is considered permissible at the present time. While the employment of animal figures for decorative and architectural purposes must be under the constant and rigid surveillance of a sensitive and cultivated taste, it is yet true that the tasteful employment of such forms would enhance the power and widen the field of decorative art among us many fold. The legitimate employment of fancy in combining native, animal and vegetable forms in designs suited to external and internal decoration would do much to produce that novelty and variety which at present is achieved at the expense of all ideas of suitability, by patching together fragments of designs from every clime and age.

Such was the field as it outlined itself before the writer upon assuming the responsibility of preparing a final report on the mammals of Minnesota. About six months having been abstracted from the twenty-four allotted for the work, it was necessary, not only to omit many of the departments which at first were contemplated, but to restrict others to the briefest possible time. It was obvious from the first that little or nothing could be added to the systematic part of the subject, which has had elaborate attention at the hands of specialists, who have access to the vast collections secured by the government. Few contributions relating to the habits of North American mammals could be expected which would not be already forestalled from the life-long experience of field naturalists like Audubon and Richardson. Even the collection of synonomy is impossible apart from the libraries of the east. A fruitful field seemed open in the careful study and painstaking description of the anatomy of our animals, especially such points as might be of permanent service to the paleontologist. It was therefore resolved to present as complete an account of the osteology of our mammals as time and opportunities would permit, and such other anatomical data as could readily be gathered at the same time. Circumstances, above alluded to, leave even this task unfinished and the osteological notes must be regarded as fragmentary material, preparatory to a comprehensive osteology of American mammals.

Such popular material as circumstances have afforded is added, the descriptive matter being, so far as possible, original, although supplemented by whatever seemed desirable in works of previous writers.

CHAPTER I.

The first question which we encounter is "What is a mammal?" Every one is practically familiar with a greater or less number of mammals, and is possessed of a more or less distinct notion of the points of similarity and diversity between such of these animals as are most familiar, but it may be suspected that such of my readers as are not themselves naturalists may not be prepared to state the distinctions which separate mammals from all other animals. It is remarkable how few ideas are united in the popular conception represented for example by the words cow, dog, cat, etc. We may perhaps think of a cow as an ungainly quadruped with hoofs and horns, which occupies herself in chewing a cud and brewing milk. One familiar with country life will be likely to add that the hoofs of a cow are divided and the horns are furnished with a core of bone and not, like those of an elk, solid and deciduous and, perhaps, that there are certain peculiarities in the dentition. A keen observer would recall that there are really four hoofs which represent four toes on each foot, that the stomach is curiously differentiated and thus exhaust what are popularly considered the distinctive features of a bovine. So able a writer as John Fiske speaks of a "hoof as made up of five claws grown together and furnished with a nail in common." (*The Destiny of Man*, p. 36). Yet few would ever have thought to inquire which of all these points does a cow have in common with a mouse, a kangaroo or an elephant, which animals are as truly mammals as the cow or her master.

The mammals are members of the sub-kingdom *Vertebrata* among the prominent characters of which are the following: The body is composed of two cavities of unequal size, the uppermost of which contains the central part of the nervous system, or, in other words the brain and spinal cord, while the lower cavity contains the viscera. The nervous cavity is separated from the visceral by a chain of bones which usually also sends up bony walls which completely enclose the organs contained in it. The anterior portion of the nervous system or brain is usually highly developed and encased in a complicated

box, known as the skull. Through openings in the skull the nerves passing from the brain to the organs of sense emerge. When the spinal column is ossified, it is divided into distinct elements or vertebræ. The vertebral column is the central support as well as the axis of the body. Nearly all paired organs are symmetrically arranged on either side of it. The bones which constitute the framework of the body and limbs are directly or indirectly attached to it. Of external movable limbs used in locomotion there are never more than four which although variable in position and function may always be recognized as a posterior and anterior pair. The heart is ventral, that is, on the same side of the vertebræ as the alimentary system.

Vertebrates are of five distinct sorts which constitute the classes *Pisces* (fishes), *Amphibia* (frogs and salamanders), *Reptilia* (reptiles), *Aves* (birds), and *Mammalia* (mammals). Of these five groups the first two and the second two are more naturally allied with each other than with any of the other classes. This more intimate relationship is indicated by uniting fishes and batrachians under the common term *Icthyopsida* and the reptiles and birds under the name *Sauropsida*. (The terms *Branchiata* and *Monocondyla* are of the same extension as the above, but less convenient. In order to preserve uniformity in the number of sub-divisions, Mammals are sometimes given as the only class under the province *Zygencephala* co-ordinate with the above.) As distinguished from these groups, Mammals possess the following pecularities:

The female has mammæ or glands which secrete a milky fluid to sustain the young, which, after birth, pass through a long period of comparative helplessness. The two halves of the anterior part of the brain (cerebrum) are connected by a *corpus callosum*. There are two condyles or articulating surfaces at the back of the skull. The lower jaw is composed of a single bone on each side and the ear contains the malleus and incus. The heart has four chambers and a single aortic arch. The diaphragm is perfect and the lungs are freely suspended in the thoracic cavity thus formed.

The ribs join the sternum. There are no gills at any time in life. Blood is warm and the red corpuscles unnucleated. The body is covered more or less completely with hair.

The scientific definition of a mammal would comprise the points above mentioned and others of similar nature, but practically the notion which springs unbidden in our minds when the

word mammal is heard is derived, not from such a rigid analysis as is necessary to formulate a scientific definition, but from mental images of various mammals and these concrete images commonly are more or less clearly or vaguely implied even in the abstract notion mammal. Such abstractions are only in so far valuable as they serve as keys to admit us with promptitude to that chamber of our memory where are stored the various concrete images which experience has gathered and which may be compared with each other and thus produce an indefinite series of abstract notions, varying in extension without altering the fundamental conceptions of concrete things in the least. A classification is in fact nothing but just such a series of general notions and is, therefore, capable of being extended to any number of terms, not greater than the number of the individuals classified which are not positively identical. The person, then, who desires to become conversant with zoology, or any other branch of natural history, must strive to gather as great a number of clear individual images of as great a variety of objects as his mental classification will enable him to retain without confusion.

It will be our aim then to present a verbal and pictorial image of all the mammals in our state, hoping to thus impart more real information than would be derived from lengthy and perchance learned discussions of the principles of classification or theories of derivation or development.

The following statistics will briefly summarize the mammalian population of our state:

1. Number of species known to exist.....63
2. Species rapidly approaching extinction..... 8
3. Species increasing in abundance..... 6
4. Species of economic value.....21
5. Species which may be regarded as injurious.....24
6. Species having northern or sub-arctic affinity..... 6
7. Species having a western affinity..... 8
8. Species belonging to the eastern province.....25
9. Species of general distribution in North America.....24

Of course in a relative matter of this sort opinion would vary as to the inclusiveness of one or other of the categories; the above table will merely indicate the approximate state of the fauna.

Among mammals either actually extinct in our limits or likely to be so may be mentioned the buffalo, prong-horn, beaver, wolverine, elk, caribou, gray gopher, and panther. The introduced species of mice and rats are on the constant increase,

supplanting in many cases native species. Instances of mammals of economic importance either on account of the value of the pelt or the food furnished by the flesh will readily suggest themselves. The fur trade in this state seems to have diminished in importance, so that statistics of its income would have little value, at any rate it was impossible to gather any information sufficiently reliable to be worth reporting. A few Indians devote their time to trapping, but aside from this, the farmer's boy who hopes to add to a limited stock of spending money, by the capture of mink or musk-rat, is almost the only patron of the industry.

The capture of deer is still quite an industry, and yet the supply does not seem to diminish greatly. Only a few years ago, patient sportsmen succeeded in securing a deer or two within a dozen miles of Minneapolis every winter.

It would be interesting to trace, so far as possible, the origin of domestic animals in this connection. The space at our disposal prohibits more than a cursory word. For additional details one may refer to the works of Oscar Smith, Rutemyer and Vogt.

Darwin was of the opinion that the domestic dog is a result of the domestication and interbreeding of several feral species.

Jeitteles believes that the jackal and Indian wolf (*Canis pallipes*) have been the progenitors of the various races of domestic dogs. From the former he derives terriers and turnspits, while from the latter he traces the poodle, cur, and bulldog. The Egyptian dog is believed to have had a separate origin from the large jackal (*Canis lupaster*).

The fossil ancestors of the wolf may be found in the Diluvium, over half a dozen species very much like the modern animal being known. There are a number of wild dogs with a greater number of molar teeth than our familiar species, and these are thought to be the more direct descendants of the primitive canine. Of the relations of the dogs to the cats enough information is furnished by paleontology to show that the petty jealousy still existing is as might be supposed a result of consanguinity unwillingly recognized.

Among the ruminants it is interesting to recall that America is the primitive home of the camel tribe. In the Pliocene Tertiary camels were perhaps the most abundant of the larger mammals with the exception of horses, while the alpaca and llama alone survive to the present.

The ox is supposed to be derived from three ancient species (*Bos brachyceros, B. primigenius, B. frontosus*) which have since been crossed interminably. While the ox seems to have appeared in the eastern continent, America may claim to have been the birth place of the bison whose enormous herds were once so characteristic a feature of our country. *Bison latifrons* from the diluvium is the first form known. Allen believes that from this species have sprung *B. antiquus* in America and *B. priscus* in the old world, the precursors of the living species in each.

One group of mammals—the Cetacea—have left no trace in the formation of Minnesota. Our knowledge of the whale is a very recent acquisition and is chiefly derived from the careful researches of Eschricht, Brandt, Van Beneden, Gervais and Flower. Whalebone had long been an article of commerce before the relation it sustained to the teeth of other mammals was made out—that it is, indeed, a thickened appendage to the mucus membrane of the mouth, used in straining out of the water the minute animals serving its owner for food. The discovery that the young or fœtal bearded whale has teeth, which are never cut, but are soon reabsorbed, deserves to be noted here as a remarkable instance of unexpected genealogical testimony. We are thus informed that the present whales are lineally descended from toothed whales not unlike the dolphin. The cetaceans were most plentifully represented in the Miocene period and at that time the two groups of whales were less clearly marked. It is certain that the whalebone whales are the latest members of the group historically. The origin of the group is shrouded in mystery, a more or less obvious similarity in certain osteological features to the omnivorous hoofed animals being the only clue as yet available.

SUB-CLASS MONOTREMATA.

This sub-class contains the principal orders of mammals and all of those included in this work with the exception of the opossum, which is the sole North American representative of the sub-class *Didelphia*. The characters of the sub-class, so far as here necessary, are the following: Development of the fœtus is accomplished through the agency of a placenta formed from the allantois membrane. The mammary glands have teats. There is, in the female, a single vagina. There is no cloaca.

The caracoids are absent or are represented by small processes of the scapula. There are no marsupial bones. The ear has a complicated spiral cochlea. The young are brought forth in an advanced stage of development, not requiring to be forcibly fed by the mother. The *corpus callosum* is large and the angle of the mandible is not inflexed.

The sub-class Monotremata includes the orders *Carnivora*, *Rodentia*, *Insectivora*, *Edentata*, *Chiroptera*, *Primates*, *Pinnipedia*, *Cetacea*, *Sirenia*, *Proboscidea and Ungulata*, or in other words, all the cats, dogs, bears and weasels, all the squirrels and rabbits, shrews and moles, sloths and ant-eaters, bats and flying foxes, seals and walrusses, whales and dolphins, sea-cows and dugongs, elephants and tapirs, and all the kine and horses as well as all races of mankind.

As being most highly specialized and departing most from what is assumed as the primitive type of mammalia, this sub class is considered the highest of the three. Fossils indicate that the lower sub-classes were once proportionally more nummerous, especially the marsupials.

CHAPTER II.

ORDER CHIROPTERA

THE BATS.

This remarkable group of animals is at once the least understood and most interesting of the mammalia. The order is a large one, including over four hundred species which are very artificially arranged in from fifty to sixty genera. North America is quite poor in species as compared with the tropical regions of both hemispheres. The number of species in the United States does not exceed twenty, only five of which are as yet known to enter the limits of our state.

The bats are very abruptly separated from all other animals whatever, and even the paleontological records reveal no intimate relationship with other mammals. The oldest known bats, remains of which have been found in the rocks, are as distinctly bat-like and as little like other mammals as those which now flit about upon moon-lit evenings.

Bats are primarily distinguished from all other mammals by the possession of true wings. There are, indeed, flying squirrels, flying marsupials and flying lemurs, but in none of these cases is flight occasioned by true wings formed by the modification of the anterior extremities. Sharing this peculiarity as they do with birds alone among vertebrates, there are vastly fewer points of similarity than of difference between the two groups. The wing of a bird is produced, it is true, from the hand and arm, but in a far less perfect manner, or anatomically considered, at a great sacrifice of the pentadactyl plan on which the hands of most vertebrates are framed. That the less perfect instrument is able to effect more vigorous and longer sustained flight in many cases is due to other reasons, such as the superior lightness of the frame of birds. There are but two evident fingers in birds and only three are represented by bones. Bats commonly possess five more or less perfect digits, four of which constitute the ribs for the support of the delicate and sensitive web which is the chief instrument of support

during flight. The first finger may be reduced to a single phalanx and the other digits may also be somewhat reduced but they never coalesce as in birds. The thumb is commonly furnished with a nail which frequently serves as a support during the day-time or period of winter repose. The other fingers are greatly elongated and are very strong and elastic. Usually if a bat is brought down by a blow it will be found that the humerus, or short bone of the arm, is broken while the more slender phalanges are intact.

The volatory apparatus, however, consists, besides the wing of various other membranes, or rather continuations, of the web above mentioned. The humeral portion is a triangular gib-like membrane passing from the wrist to the sides of the neck or shoulder, and is, in some species, pocket-like. There is also a broad membrane passing posteriorly to the legs. This web corresponds to that expansion of the skin which forms a parachute by which flying squirrels "fly." Another portion, the interfemoral membrane, connects the feet with each other. The tail is ordinarily included in this membrane, but its apex may extend beyond, or it may be entirely wanting. In some species the leg is armed with long spurs homologous with the cartilage upon the wrist of the flying squirrel which serve as supports to the web.

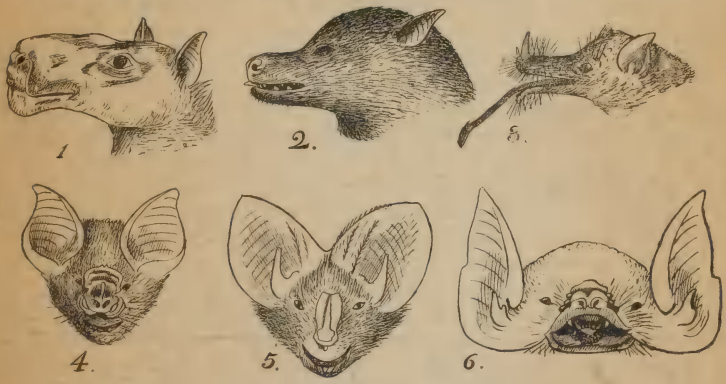
The form is various, but is uniformly plump with a short neck and thick body.

When not in motion the ensemble is bizarre and formless. (See Fig. 1, heads of various bats.) The smaller bats resemble mice in their pelage and general appearance and are retaliative and fierce when caught.

The head is rendered remarkable by enormously expanded ears, often provided with a large simple or lobed tragus which serves as a sort of valve for closing the ear. In many species the nose is also ornamented with extraordinary folds of skin, which seem to be the seat of the delicate tactile sense for which bats are distinguished. The eyes of bats are very small, and seem adapted to the peculiar nocturnal habits of the animal, but are supplemented by the senses of touch and hearing. In a room, across which wires have been stretched in all directions, a bat will fly freely without dashing against them even when the eyes are destroyed or blindfolded.

The volar membrane is itself very sensitive, being richly supplied with nerves as well as bloodvessels. In the eye of nocturnal animals, generally the spindle-shaped bodies in the

retina, which seem to be the seat of the color sense, are absent, and it is supposed that all variations of color are translated into shades of black and white, so that the world seems to a bat like a charcoal drawing or steel engraving. The sense of hearing is highly, but peculiarly developed. The reader may have noticed that the vocal powers of bats are not great, and that the voice is pitched very high, so high indeed, that, to many ears, the tones are indistinguishable. The sense of hearing is similarly keyed, so that the bat can readily distinguish tones which the human ear is not adapted to perceive. Thus the hum of an insect which will startle a bat could only be appreciated by us as we observe the motion of the wings causing it.



EXPLANATION OF FIG. 1.

1. Epomophorus.
2. Pteropus.
3. Chæronycteris.
4. Phyllorhina.
5. Megaderma.
6. Chilonycteris.

The bats of temperate regions pass the winter in caverns and deserted buildings, where, collected in vast numbers, they sleep during the cold season. The winter's sleep varies in length and soundness with different species. A sort of classification may be observed in the myriads of animals which congregate in such places, those which are least susceptible to cold being found in the more exposed portions, while the more sensitive ones are found in securer retreats. Bats congregate in such rendezvous from great distances and the period during which the scattered tribes are gathering is one of commotion, quarreling and screaming. The sleepy animals are in a petulant humor and struggle for the best places so as to be most aptly compared to a covey of chickens settling themselves upon their

roosts at night. In such resorts, which are ordinarily used during summer as sleeping places during the day, immense quantities of guano are deposited which become valuable as nitre supplies. Thus the insignificant bat plays no insignificant part in the warlike preparations of militant nations, as the nitre so secured is an essential factor in gunpowder. During hibernation and daily sleep, bats are in danger from prowling animals which creep upon them when at rest; while during their hawking excursions after insects they frequently fall victim to the nocturnal birds of prey.

Bats may be reckoned among the beneficial animals, as their food consists almost exclusively of insects in temperate regions. They are aptly compared to swallows, as their benevolent intent and their graceful motions are both similar. The bats of the tropics are larger and do not content themselves with insects and other small arthropods. Various fruits form a welcome contingent, if not the staple of the diet, while still others are bloodthirsty enemies of large animals which they attack stealthily, sucking the blood painlessly and escape unperceived.

The hair of bats may be distinguished from that of other mammals by its peculiar microscopical structure. The fine fur is a refuge for many parasites of various sorts. It remains to mention the anatomical peculiarities of the group.

The dentition is extremely variable, but in general resembles that of the Insectivora. The greatest diversities are found between the frugivorous and insectivorous bats. The number of teeth varies from 24 to 38. The statements of various authors vary greatly as to the number of teeth—a fact caused by their deciduous character, particularly of the incisors and premolars. The molars have two or three points which are variously arranged and those of opposite teeth fit between each other. The incisors are small and above are often arranged in oblique series not meeting in the median line. The milk dentition is quite different from the permanent.

Most species produce but a single young at a birth or at most two. The mother hangs by the thumbs, it is said, and the young are dropped into a pocket formed by the incurved tail with the membranes attached. Here they remain clinging for a day to peculiar processes between the thighs, or at once clamber up to the two pectoral mammæ. Although northern species mate ordinarily in Autumn, eggs are not fertilized until Spring, when impregnation takes place. The placenta is disc-like and the uterus has two cornua. The penis is pendulous.

The form of the skull is extremely variable and affords a safe guide to the habits of the various species. Compare, for instance, the skulls of *Chœronycteris* and *Chilonycteris*. Most of the true bats have no post orbital frontal processes. The nasals are generally short and vary much in form. The most remarkable differences are found in the form of the pre-maxillary bones. In *Rhinolophidæ*, they are rudimentary. The zygomas are well developed in the flying foxes, but are wanting in several species of true bats. The auditory bullæ are usually large and well developed. The vertebral column is short. The dorsal vertebræ number twelve or thirteen. The caudal vertebræ are cylindrical, without processes. There are also no spinous processes upon the cervicals and dorsals. The clavicles are strong and curved. The scapula is large, the post scapular fossa being much the larger, the spine is large, as are the acromium and the coracoid. Although the humerus is long, it is greatly exceeded by the bones of the forearm and all these bones have large medullary cavities. The ulnar is rudimentary; the scaphoid, lunar and cuneiform bones are united.

The thumb terminates in a claw as does the index in many forms. The pelvis is weak. The pubic bones are widely separated in the females. The fibula is often rudimentary. The calcaneum forms a long cartilaginous process or spur which supports the interfemoral web. The sensory apparatus, already referred to, consists of several peculiar foliaceous expansions about the nose and ears as well as the ordinary organs. Aside from these are glandular appendages near the muzzle covered with fine tactile hairs like the vibrissæ of other animals. The ears are also greatly developed, with membranous expansions and fringing appendages in many species. Each ear is movable independently. The lips are often curiously modified and are very sensitive. The alimentary canal is quite complicated in the frugivorous bats but has the ordinary carnivorous structure in entomophaga. The liver is always large.

For farther details regarding the anatomy the reader is referred to the discussion of our native species.

Here it may not be amiss to pass in review a few of the more important families and genera.

It is common, first of all, to divide the Chiroptera into two sub-orders. Sub-order *Carpophaga* or the fruit-feeding bats embraces the flying foxes and includes but the single family *Pteropodidæ*.

The family *Pteropodidæ* is characterized by a relatively large size and the peculiar dentition. The head is fox-like or dog-like and there is no remarkably developed tragus, the ear being of ordinary form. The first finger has usually a curved claw and is very short. The middle finger has but two phalanges. The skull is elongated. The molars have blunt tubercles, nevertheless the dentition is to be considered as a modified insectivorous rather than a vegetarian type, as is indicated by the sharp and well developed canines. The peculiar form may be construed as the result of long continued vegetarian habit. The digestive tract also indicates a vegetable diet, a well developed cæcum being present. None of the species suck blood although they do feed upon small animals.

The principal genus is *Pteropus* which includes the largest of bats, some of which measure nearly two yards in expanse of wings. Over fifty species or over half the family are included in this genus. The genus is at home in Australia and adjacent lands. Some species furnish a relished food.

The other genera are as follows: *Cynonycteris* Peters, occurs in Africa and the species are characterized by short tails and the following dentition: $\frac{3}{3}:\frac{2}{2}\ \frac{1}{1}\ \frac{4}{4}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. *Cynopterus* Geoff., and *Ptenochirus* Peters, both have a formula $\frac{2}{2}:\frac{2}{2}\ \frac{1}{1}\ \frac{4}{4}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$, the latter having the tail distinct. In *Megærops* Peters, the tail is absent and the formula is $\frac{2}{2}:\frac{2}{2}\ \frac{1}{1}\ \frac{4}{4}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$—the only species inhabiting Sumatra. *Harpyia* Illiger, has a still more peculiar dentition, $\frac{2}{3}:\frac{2}{2}\ \frac{1}{0}\ \frac{2}{1}\ \frac{2}{2}:\frac{3}{3}$ and is found represented by one species in the Celebes, etc. *Epomophorus* Bennett, has a short tail, the dental formula being $\frac{1}{2}:\frac{2}{2}\ \frac{1}{1}\ \frac{4}{4}\ \frac{1}{1}\ \frac{2}{2}:\frac{1}{2}$. The eight or more species inhabit Africa including the *Hypsignathus* of Allen. The dentition of *Cephalotes* Geoff., is $\frac{2}{2}:\frac{1}{2}\ \frac{1}{1}\ \frac{2}{2}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. The tail is short, the volar membrane springs from the spinal region, and the index has a nail. *Macroglossus* Cuv., contains two species found in Siam and Australia. The tongue is long and protrusible, the dentition is $\frac{2}{2}:\frac{2}{2}\ \frac{1}{1}\ \frac{4}{4}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. The genus *Pterocyon* is represented by a single African species.

The suborder *Entomophaga* contains all other bats. The dentition is like that of the Insectivora with pointed cusps upon the molars. The thumb only has a claw and the muzzle is short.

The first group, Phyllostomata, contains families which have large membranous processes on the nose.

The family *Megadermata* has well developed nasal appendages and large tragi or ear valves. The single phalanx of the index is short. The Genus *Rhinopoma* is represented by a single Egyptian species. The nose is but slightly appendaged, the tail long and mouse like, while the dental formula is $\frac{1}{1}\ \frac{1}{1}\ \frac{1}{2}\ \frac{3}{3}$. The warmer regions of Asia and Africa furnishf our species of the genus *Megaderma*. The tail is absent, the interfemoral web extensive. Dentition varying from $\frac{2}{1}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$ to $\frac{2}{1}\ \frac{1}{1}\ \frac{1}{2}:\frac{3}{3}$. Closely related is *Nycteris* Geoff., which has a membrane connecting the ears. Ten species mostly from Africa with dentition $\frac{2}{3}\ \frac{1}{1}\ \frac{1}{2}:\frac{3}{3}$.

Nyctophylus and *Antrozous* are given as generic names under this family.

The *Rhinolophidæ* constitute the second family of leaf-nosed bats. These horse-shoe nosed bats have large appendages upon the nose. The index digit is reduced, the second digit has two phalanges. The tragus is wanting. The skull is remarkable for a prominent excrescence of the nasals and the peculiar form of the intermaxillary, the horizontal part alone being developed, forming a movable plate. The family is found in

all parts of the world except America. Many of the species are very widely distributed. E. Geoff. St. Hilaire distinguished the family[1] under the generic name *Rhinolophus* which is now restricted to include about thirty species of this large family. Dentition $\frac{1}{2}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. Upper nasal appendage lance-shaped, pointed. First toe two-jointed, others three-jointed, spurs well developed.

Genus *Phyllorhina*, Bonaparte. Dentition $\frac{1}{2}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. All the toes two-jointed, tail long, spurs well developed. Over twenty-five species from Africa and eastward. The genus *Cœlops*, Blyth, has the some formula. The nasal appendage is two-lobed with a heart-shaped prominence. Toes all two-jointed. Interfemoral membrane angularly excised. Only one species found in Bengal.

The third family is the *Phyllostomidæ*.

This very extensive family of Vampire bats is confined to South America. In most genera only two small but broad incisors are found above. The canines are very large, particularly below. The tall is often absent. The vampire bats, although insectivorus ordinarily, sometimes inflict damage by sucking the blood of domestic animals and particularly of horses, kine being nearly exempt from their attacks. In the sub-family Vampyri are nine genera only two of which, *Phyllostoma* and *Vampyrus*, are rich in species. The formula for the dentition of the vampires is $\frac{2}{2}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. The tail is frequently absent.

The second sub-family *Glossophagæ* differs from the Vampyri in lacking the horse-shoe appendage of the lip and in having the lower lip cleft. The tongue is protrusible. As in the above the middle finger has three phalanges, and the tragus is present. Genus *Glossophaga* with the inner upper incisor more highly developed than the outer. The crowns or the molar have a W-shaped figure. The zygoma is entire. Dentition $\frac{2}{2}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. Upper and lower incisors forming a connected series.

The genus *Monophyllus*, Leach, differs in having the incisors in pairs, the lower being small. The interfemoral membrane is small, the short tail extending beyond it.

The genus *Ischnoglossa*, Sauss, has a single doubtful species with no tail. *Phyllonycteris*, Gundlach, has the formula $\frac{2}{2}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. The zygoma is absent. One or two species inhabit the Antilles. *Peltorhinus* contains a species from Jamaica *Lonchoglossa*, Peters, has the formula $\frac{2}{2}\ \frac{1}{1}\ \frac{2}{2}:\frac{3}{3}$. Inner upper incisor smaller than the outer. Lower ones deciduous, zygoma present. One species in Brazil. *Glossonycteris*, Peters, has the inner upper incisor smaller than the outer. Zygoma absent. Formula as in the above. *Chœronycteris*, Lichtenstein, also has the same formula. Lower incisors and first upper premolar deciduous. Anterior molars very small, only provided with an anterior prominence. Two species inhabit Mexico and Surinam.

The geographical distribution of bats furnishes a number of interesting facts. The order is represented in almost all parts of the globe and the species are most numerous in the warmer

1. Fitzinger in 1869-70 gave a compiled account ofthis family which, although entitled a "critical review of the Rhinolophi" in the Sitzenb. d. Wiener Akademie der Wissenschaft seems to include many synonyms and to omit some modern species. The most reliable account seems to be that of W. Peters, June, 1871, in the Monats bericht der Kœnigl. Akad. zu Berlin, from which our statements are taken.

zones. The few isolated regions where they do not occur, as Iceland, St. Helena, Galapagos Islands and Kerguelan Islands are mostly such as have few flying insects. The faunas of the eastern and western hemispheres are very distinct. But one species and three genera and two families are represented in both.

The *Vespertilionidæ* have the widest range of any of the families of bats, the *Emballonuridæ* being next in order of extent. The *Pteropodidæ* are found in the Ethiopian, Oriental and Australian regions, the Malay Archipelago being, perhaps, the central point.

The *Rhinolophidæ* are restricted to the eastern and the *Phyllostomidæ* to the western hemisphere. There are many instances of apparently arbitrary restriction of species and genera to limited stations, but more of unusually wide distribution. Of the origin of the group we have no knowledge. The oldest fossil bat is from the Eocene of Montmartre and differs very little from the modern genus *Vespertilio*. It can not be doubted that the type is a very old one and in spite of several apparent links with the Insectivora, it is not impossible that the bats are derived from a primitive and perhaps an aquatic vertebrate allied with Amphibia.

Linnæus knew seven species of bats while the present enumeration includes above four hundred species.

Dr. Harrison Allen in his monograph of the bats of North America, published by the Smithsonian Institution in the Miscellaneous Collections, 1867, enumerates twenty species, several of which must be regarded as synonyms.

Mr. J. A. Allen mentions six species from New England in his catalogue of the mammals of Massachusetts published in the Bulletin of the Museum of Comparative Zoology.

This number is naturally greater than can be expected from a single inland state. Only three species have been collected during the progess of this survey, which are described together with the notices of the species otherwise known to occur in our limits.

Only one leaf-nosed bat occurs in the United States, the *Macrotus californicus* of Baird, which occurs in California, southward. The *Noctilionidæ* are represented by a Mexican species, *Nyctinomus nasutus*.

Several genera of the Family *Vespertilionidæ* occur as follows:

GENUS NYCTICEJUS, RAF.

This genus is defined as follows by Dr. Harrison Allen:

Head short, broad, flat; ears small, simple, widely separated; upper incisors two; membranes naked.

Skull intermediate between that of *Scotophilus* and *Lasiurus*, flat, but not to the extent seen in the former; cranium inflated, but not so much as in the latter. It is not elevated; the occipital elevation is not abrupt compared with that of *L. noveboracensis*, a bat of nearly the same size, it is longer, and the face more pointed. The palate is more level and does not slope so much as its posterior part. The infra-orbital foramen is larger, with a slight tendency toward the formation of a groove. The lower jaw is less abrupt; the incisors are placed more anteriorly to the canines in a larger arc.

Dentition—incisors $\frac{1}{3}$, canines $\frac{1}{1}$, molars $\frac{4}{5} \times 2 = 30$. Upper jaw: Incisors small, contiguous to canines, and slightly converging; canines large, simple. Molars not peculiar. The first more slender and longer than the others, but not so broad, destitute of the W-shaped crown.

Lower jaw: Incisors not crowded, bifid. Canine simple. turned markedly backward; basal ridge anteriorly well developed; first premolar larger than the same tooth in *Lasiurus*, but in comparison with the second is of itself small. The second premolar, if produced, would touch an extended line from the canine. The basal ridges of both these teeth are large. Molars not peculiar.

Nycticejus crepuscularis LEC., SP.

TWILIGHT BAT.

Vespertilio crepuscularis LECONTE. Cuv. An. King., 1831; Proc. Acad. Nat. Sci. vii, 1855.
Vespertilio creeks FR. CUVIER. Nouv. Ann. du Mus., 1832.
Nycticejus humeralis RAFINESQUE. Journ. du Phys., 1819.
Nycticejus crepuscularis H. ALLEN. Smith. Misc. Coll. vol. vii, 1864.
Nycticejus crepuscularis DOBSON. Catalogue Chiroptera, 1878.
Atalapha (*Nycticejus*) *crepuscularis* COUES. SURV. 100th Mer. Rep. Zool., 1875.

Color somewhat variable, face black, membranes blackish brown, back dark fawn to brown, below lighter, brownish ears small, "internal basal lobe small and curved, external basal lobe also rather inconspicuous, between the latter and the angle of the mouth a small wart is present," tragus straight on the internal and irregularly convex on outer border. Sides of face swollen, chin with a naked space, eyes small with a wart above

each. Interfemoral web moderate, calcaneal small, tip of tail exserted.

Fur scanty, rather woolly, membranes naked.

Length 2, tail 1.5, fore-arm 1.4, tibia 0.6, thumb 0.4, ear 0.4, tragus 0.25, expanse of wings 9.6.

Although not reported, this species may be found in Minnesota.

GENUS LASIURUS, RAF.

(=Atalapha.)

I have not the necessary advantages for deciding which name should be employed for this genus and hence follow American usage. Some ten nominal species are known from North and South America. Three species occur in the United States two of which are known from Minnesota.

Skull massive, broad, high posteriorly; facial portion rather high, passing with little flexure into the cranial, nasal portion very broad, hiatus between the upper incisors of either side wide, quadrately excavated. Zygoma complete. Distance between the orbital space and the front of skull very short. Pterygoids projecting inferiorly. Dentition, *i.* $\frac{1}{3}$ *c.* $\frac{1}{1}$ *m.* $\frac{5}{5}$ $(\frac{4}{5})$ $\times 2 = 32$ (30). Last upper molar greatly compressed from before backward. Scapula elongated with very long metacromial and caracoid processes. This genus differs from *Nycticejus* in the fact that the anterior premolar, although small, is present

Lasiurus noveboracensis ERXL., SP.

RED BAT.

Vespertilio noveboracensis ERXLEBEN. Syst. Reg. Anim., 1777.
HARLAN. Fauna Americana, 1825.
GODMAN. Amer. Nat. Hist., 1826.
COOPER. Ann. Lyc. Nat. Hist. N. Y., 1837.
LECONTE. Proc. Acad. Sci., 1855.
Nycticejus noveboracensis LECONTE. Cuv. Regn. Annual, 1831.
TEMMINCK. Monog. ii, 1835-1841.
WAGNER. Suppl. Schreb. Säuget., 1840.
SCHINZ. Synopsis Mam., 1844.
MAX. WIED. Archiv. Naturg., 1861.
Lasiurus noveboracensis TOMES. Proc. Zool. Soc., 1857.
H. ALLEN. Monogr. N. A. Bats, 1864.
BAIRD. Mam. N. A.
J. A. ALLEN. Catalogue Mam. Mass., 1869.

Vespertilio lasiurus GMELIN. Syst. Nat., 1788.
SCHREBER. Säug., 1826.
GEOFFROY. Ann. du Mus. viii, 1806.
DESMAREST. Mammals, 1820.
FISCHER. Synopsis Mam., 1829.
Nycticejus lasiurus WAGNER. Schreb. Säug., 1840.
Vespertilio rubellus BEAUVOIS. Cat. Peale's Mus., 1796.
Vespertilio villosissimus GEOFFROY. Ann. du Mus. viii, 1806.
DESMAREST. Mam., 1830.
FISCHER. Synop. Mam., 1829.
Vespertilio monachus RAFINESQUE. Am. Monthly Mag., 1817.
Vespertilio tessalatus " " " " "
Taphyzous rufus HARLAN. Fauna Americana, 1825.
Lasiurus rufus GRAY. List Mam. Brit. Mus., 1843.
GOSSE. Naturalist in Jamaica, 1851.
Vespertilio blossevilii LESS ET GARN. Bull. des Sci. Nat. viii.
FISCHER. Synopsis Mam., 1829.
LA SAGRA. Hist. de l'Ile de Cuba, 1840.
Vespertilio bonariensis LESSING. Voyage de la Coquille, 1829.
Nycticejus varius POEPP. Reise Chili. i, 1835.
WAGNER. Suppl. Schreb. Säug., 1840.
GAY. Hist. de Chili, 1848.
Atalapha (*Lasiurus*) *noveboracensis* COUES. Surv. 100th Mer. Zoology, 1875.

This species is exceedingly variable and is regarded by many authors as including the following. A point upon which the writer can express no opinion on account of the poverty of the material at command. I shall quote Allen's description and add such other points as are available:

"Head and face hairy; nose blunt, rounded, slightly emarginated, nostrils opening semilaterally. The sides of the face slightly inflated and set with stiff hairs. A similar row of longer hairs surrounds the eyes. The upper lip, especially at the sides of the face, is more massive than the lower, and is somewhat produced. The ears are sub-rounded—the inner border straight until near the tip when it suddenly turns outward; at its base is a well developed lobe which is close to, but slightly behind the tragus. The outer border is slightly convex, and terminates at the angle of the mouth. On a line with the outer border of the ear a sharply defined lobe is noticed, which at first appears to be the termination of the border, but upon close examination it is found to continue on to the angle of the mouth. Between this lobe and the mouth there is placed a small wart covered with setæ. The tragus is half the height of the ear, is straight on the inner edge, except at the point, where it turns abruptly inwards. The outer border has a very irregular outline. The basal portion is indentated. This indentation, which in comparison with other species of Vesper-

tilionidæ is considerable, is of itself not very deep, and ends in the most convex point of the tragus, whence the border runs upward and inward to the tip. The lower jaw is covered with short hairs, and has at its symphysis a small naked space which is gradually lost along the sides of the mouth. The posterior surface of the ear is covered with hair one-half its length, which extends upon the anterior production of the external border down to the angle of the mouth.

The fur of the body is everywhere long and silky. Anteriorly it is rather denser though not quite so long as that posteriorly. It is of a light russet red, tinged with yellow, being tipped with gray toward the neck, and varying to fawn color, in some specimens, toward the pubis. Fur of the same general hue extends from the body upon the alar membranes up to the base of the third finger of either side and blends with that upon the anterior surface of the interfemoral membrane at about the region of the tibiofemoral articulation. The hair upon the latter membrane runs down fully one-half its length in most specimens. The interbrachial expansion also possesses a sparse growth of yellowish fur. Posteriorly the fur is very long, and presents a richer appearance than anteriorly. The russet red color is here predominant in the majority of individuals, though we meet with a great variety of hues of fawn, fawn-red, and yellowish cinereous. At each shoulder a conspicuous white tuft of hair is seen; this is not elevated above the surrounding fur of the neck with which its whitish color gradually blends.

The posterior surface of the alar membranes is less extensively furred along the brachial and digital regions than the anterior surface, being here almost altogether confined to longitudinal bands extending from the neck downwards across the interbrachial membrane midway from the shoulder to the elbow, and thence continued along the sides of the body and external border of the tibia to the ankle and tarsus of either side. The dorsum of the fifth finger, for about one-third of its length, is covered with fine scattering hair. The basal joint of the thumb is decorated with a whitish tuft. The posterior surface of the interfemoral is very thickly covered over its whole area with fur of the same color as that of the body. The difference in hue of various individuals is owing chiefly to the coloration of the tips of the hair. Each hair is tinged as follows: The base dark plumbeous in color verging to black; the middle, a delicate yellowish-brown, passing outwards toward

the tip to a darkish-red, in some instances to a brighter red, more rarely to a beautiful chocolate. The point is generally white. The color of the membranes is a rich brown, bordering on a yellowish-brown, above the head. The ears and lips are marked with yellow in the same manner as in the next species (*L. cinereus*) they are marked with black."

Dr. Allen notices a tendency on the part of northern specimens to be constantly darker, the chocolate or dark red predominating, while toward the south the pelage is generally of a brighter hue.

Mr. J. A. Allen affirms that there is a well marked sexual distinction, males being uniformely lighter in color. "In a series of about twenty Massachusetts skins, nearly all marked for sex by the collector, all the males are of a beautiful light, bright, yellowish red, with scarcely a trace of the apical white; the females, though somewhat more variable, are universally darker, the light red of the males being replaced in these by dark russet, which is more or less obscured by the whitish tips of the fur."

Mr. Allen inclines to the belief that the following species is merely a variety of the present one. At least, they are very similar and extremely variable.

I regret that no opportunity has been afforded to compare the osteology of the two species, but probably the description given will apply with very slight exception to this form.

Length 1.9-2.0, tail 1.9-2.0, fore arm 1.6, tibia 0.9, longest finger 3.5, thumb, 0.45, ear 0.5, tragus 0.3, expanse of wings 12.0.

This is a widely distributed species not very common in Minnesota.

Lasiurus cinereus BEAUVOIS, SP.

HOARY BAT.

Vespertilio cinereus PALISOT DE BEAUVOIS. Cat. Peale's Mus. 1796.
LECONTE. Proc. Phila. Acad. Sci., 1855.
Vespertilio pruinosus SAY. Long's Exped. to Rocky Mts., 1823.
HARLAN. Fauna Amer., 1825; Med. and Phys. Researches, 1831.
GODMAN. Amer. Nat. Hist., 1826.
RICHARDSON. Fauna Bor. Am., 1829.
COOPER. Ann. Lyc. N. Y. iv, 1837.
DEKAY. Nat. Hist., N. Y. (Zool.), 1842.
Scotophilus pruinosus GRAY. Mag. Zool. and Bot. ii., 1838.

Nycticejus pruinosus TEMMINCK. Monogr. Mam. 1835.
SCHINZ. Synop. Mam. Mass., 1845.
MAX V. WIED. Arch. Naturg., 1861.
Lasiurus Pruinosus TOMES. Proc. Zool. Soc., 1857.
Lasiurus cinereus H. ALLEN. Monog. Bats N. A., 1864.
J. A. ALLEN. Cat. Mam. Mass., 1869.
Atalapha cinerea DOBSON. Cat. Chiropt., Brit. Mus., 1878.
BAIRD. Mam. U. S.
Atalapha (*Lasiurus*) *cinereus* COUES, Surv. 100th Mer. Zool., 1875.

In form and general appearance much like the last with which it is sparingly distributed. It may at once be distinguished in ordinary cases by the black upon the face and margins of the ears. The head is large, blunt, and moderately inflated at the cheeks. Nose emarginate, nostrils being widely separated, lateral. Ears large, sub-quadrate, strongly lobed at the base in front, margins revolute, black. Tragus rather small, anterior border nearly straight, hairy without.

Fur long, soft and thick. General color above yellowish brown with a hoary admixture; interfemoral membrane dark brown, with a heavy superficial grizzle of gray; top of head creamy yellow, with some mixture of darker and white hairs. There are a few yellowish hairs upon the humeral membrane, while the shoulders and the edge of the interfemoral membrane are strongly suffused with rufous. There is a broad collar of creamy yellow, while the breast and belly are olive brown overlaid with much yellowish white. The muzzle, lower jaw, a band including the eyes and extending upward near the forehead, and the rim of the ears are black.

The inside of the ears and upper anterior part yellow. The under parts of the wings are clothed near the humerus with woolly yellow hair; the base of the interfemoral membrane below is densely covered with dirty yellow hairs. The membranes are black, except near the fingers and bones of arm, where they are yellowish. The hairs on the back have four colors, beginning with a base of dark olive brown, nearly black, then follows a band of creamy yellow, more or less inclined to rufous outwardly, then a black band and a short white terminal portion.

Total length, 4.8; nose to anus, 2.5; nose to eye, 0.3; tail, 2·2; nose to anterior edge of ear, 0.4; height of ear (medianly), 0.6; total vertical extent of ear, 0.7; width, 0.5; expanse, 14-15; radial part of wing, 2 1; thumb, 0 4; proximal phalanx of second digit, 2.25; distal, 0.3; third digit, proximal phalanx, 2, 10, II, 0.5, III, 0.6, also bearing a curved nail giving the wing a lobate

termination, fourth digit, I, 2.10; II, 0.5; III, 0 6; also a curved nail curved in the reverse direction, fifth digit, I, 1.7; II, 0.35; III, 0.35; femur, 0.8; tibia, 0.9; interfemoral spur, 0.75.

The facial portion of the skull is much higher in the specimen figured than represented by Allen. Conspicuous is the sharp downward spur of the molar process of the temporal, and the downward inclination of the pterygoid.

The last molar above is greatly compressed and the anterior premolar may be absent.

GENUS SCOTOPHILUS.

(=Vesperus, Coues.)

Dental formula *i.* $\frac{2}{3}$, *c.* $\frac{1}{1}$, *m.* $\frac{4}{5}$x2=32.

The dental formula must alone be relied upon to distinguish this and the next two following genera or sections for though other characters exist they are not susceptible of exact formulation, but consist rather in a peculiar habitus which must be seen to be appreciated.

Scotophilus fuscus BEAUVOIS.

BROWN BAT.

Vespertilio fuscus BEAUVOIS. Cat. Peale's Mus., 1796.
LECONTE. Proc. Acad. Nat. Sci., 1855.
Vespertilio arcuatus SAY. Long's Exp. Rocky Mts., 1823.
Vespertilio phaiops RAFINESQUE. Am. Month. Mag., 1818.
LECONTE. Proc. Acad. Nat. Sci., 1855.
WAGNER. Schreb. Säug., 1855.
Vespertilio ursinus. TEMMINCK. Monog. Mam., 1835.
MAX. V. WIED. Archiv. Naturg. 1861.
Vespertilio gryphus FR. CUVIER. Ann. Mus. 1837.
WAGNER, Schreber's Säug., 1875.
Vespertilio caroli LECONTE. Proc Acad. Sci., 1855.
Scotophilus fuscus H. ALLEN. Monogr. N. Am. Bats.., 1864.
J. A. ALLEN. Cat. Mam. Mass., 1869.
Scotophilus carolinensis GEOFFROY, HARLAN, GODMAN, LECONTE, COOPER, DEKAY, TEMMINCK, H. ALLEN, ETC.
Vespertilio (Vesperus) fuscus COUES. Surv. 100th Mer., Zool., 1875.

Head flat, nostrils large, separated by an emargination; ear less than head, broad at the base, obtuse at tip; tragus about one-half as high as the auricle, notched externally at base. Interfemoral membrane ample, basal portion furred; terminal segment of tail exserted. Wing membrane attached to base of toes; spur well developed. Color on the back dusky brown,

the pelage being plumbeous at the base. Below, either grayish white or as above. On the head the hair is more lanuginous, extending nearly to the nose. The wing membrane is not furred. The skull is large, with a slight occipital crest; the orbital space is large. Dentition *i.* $\frac{2}{3}$, *c.* $\frac{1}{1}$, *m.* $\frac{4}{5}$x2=32.

The first incisors above are much larger than the second and are irregularly bifid, the internal cusp being longest; canines large, with a minute basal cusp; first molar narrow. The six incisors of the lower jaw are crowded, tricuspidate. The two anterior molars (premolars) simple.

I have no notes as to the abundance of this species.

The following description will apply to a male captured early in June, and will illustrate the typical condition of the species in Minnesota:

Total length, 4.1; tail to anus, 17.4; expanse, 12.70; radius, 1.70; thumb, 0.25; first finger, 1.62; first phalanx second finger, 1.69; first phalanx third finger, 1.58; first phalanx fourth finger, 1.50; tibia, 0.71; hight of ear medianly, 0.47; tragus, 0.30; hight of ear externally from base of opening, 0.65; ear from nose, 0.70; eye from nose, 0.38; distance between nostrils, 0.15; tail beyond web, 0.20.

General color yellowish brown, inclining to chestnut; below lighter and more olivaceous; face, ears and web black, chin and throat dark. Webs scarcely at all hairy. Cheeks tumid, slightly warty; barbæ fine, short; ears high, somewhat acute, convex on the front margin; tragus over one-third the height of ear, curved forward; basal lobe of ear of moderate size. Thumbs small. Tail exserted; soles with a callous at the heel.

GENUS LASIONYCTERIS.

(=Vesperides, Coues.)

This genus is characterized by the dental formula *i.* $\frac{2}{3}$, *c.* $\frac{1}{1}$, *m.* $\frac{4}{5}$x2=36. Central upper incisors bicuspid. Skull rather flat, not crested. Thumb rather small.

Lasionycteris noctivagans LECONTE, SP.

SILVER-HAIRED BAT.

Vespertilio noctivagans LECONTE. Cuv. An. King., 1831.
COOPER. Ann. Lyc. N. Y., 1837.
DEKAY. Nat. Hist. N. Y., 1842.
WAGNER. Schreb. Säug. 1855.
Vespertilio auduboni HARLAN. Month. Am. Journ., 1831.

Vespertilio pulverulentus TEMMINCK. Monog. Man., 1835.
LECONTE. Proc. Acad. Sci., Phila., 1855.
MAX. V. WIED. Archiv. Naturg., 1861.
Scotophilus noctivagans H. ALLEN. Monog. N. A. Bats., 1864.
J. A. ALLEN. Cat. Chir., 1869.
Vespertilio (*Vesperides*) *noctivagans* COUES. Surv. 100th Mer. Zool., 1875.
Lasionycteris noctivagans DOBSON. Cat. Mam., Mass., 1878.

Never having seen a specimen of the silvery-haired bat from Minnesota, I simply quote the description given in Allen's monograph:

"Head flat, broad and moderately haired; snout naked; nostrils wide apart, and opening sublaterally; space between emarginate. Sides of face slightly swollen. The auricle is an irregular oval. The inner border extends upwards and *inwards* to a level with the top of the head, and then turns upwards and *outwards*, ending in an obtuse point. The outer border is smooth, and terminates inferiorly and internally in a thin ridge near the angle of the mouth. The lower half of this border folds irregularly upon itself, and bends so markedly inwards as to touch the tragus. The tragus is straight internally, strongly and abruptly convex externally, narrow at its base. It is but one-third the hight of the auricle, and nearly as broad as high. Skin of face and ears blackish, with the exception of the internal basal lobe of the latter, which is whitish. Fur long and silky, with a marked tendency to become black, and in many specimens the extreme tip of each hair is the only part possessing a different hue—it being pale gray or white. The fur is thicker on the back than in front, but the coloration is very similar. The posterior part of the interfemoral membrane is thinly covered with short dark colored hairs; the anterior surface has upon it numerous minute tufts arranged linearly. Thumb small, foot moderate.

Dentition *i.* $\frac{2}{3}$, *c.* $\frac{1}{1}$, *m.* $\frac{5}{6} \times 2 = 36$.

Upper incisors closely approximate to but not touching canines, nearly of the same length; median pair bifid, twisted on their axes so that the two cusps have a somewhat antero-posterior arrangement; internal cusp slightly longer. Lateral pair unicuspid with a basal cusp. Canines simple and moderate. First premolar very small, unicuspid, second premolar with a very long external and short internal cusp.

In the lower jaw the incisors are not crowded, trifid. Three premolars, of which the second is smallest.

GENUS VESPERTILIO

The generic term as thus restricted includes such bats as, having four upper and six lower incisors, have also six molars above and below on either side, or 38 teeth in all, thus: *i.* $\frac{2}{3}$, *c.* $\frac{1}{1}$, *m.* $\frac{6}{6}$x2=38. Wings and ears thinner than in the preceding; skull less heavy, cranial portion inflated, upper outline concave.

Vespertilio subulatus SAY.

LITTLE BROWN BAT.

Vespertilio subulatus SAY. Long's Exped. Rocky Mts., 1832.
HARLAN. Fauna Amer., 1825.
RICHARDSON. Fauna Bor. Amer., 1829.
GODMAN. Am. Nat. Hist., 1831.
COOPER. Ann. Lyc. N. Y., 1837.
DEKAY. Nat. Hist. N. Y., 1842.
WAGNER. Schreb., Säug., 1855.
LECONTE. Proc. Acad. Phila., 1855.
H. ALLEN. Monog. Bats N. A., 1864.
J. A. ALLEN. Cat. Mam. Mass., 1869.
BAIRD. Mam. N. A.
COUES AND YARROW. Surv. 100th Mer. Zool., 1875.
DOBSON. Cat. Chir. B. M., 1878.
Vespertilio californicus BACHMAN. Journ. Phila. Acad., 1842.
PEALE. U. S. Expl. Exped., 1858.
Vespertilio caroli TEMMINCK. Monogr. Mam., 1835.
WAGNER. Schreb. Säug., 1855.
Vespertilio domesticus GREEN. Cab. Nat. Hist.
Vespertilio evotis H. ALLEN. Monogr. Bats N. A., 1864.
Vespertilio lucifugus LECONTE. Cuv. An. King., 1831.
MAX V. WIED. Verzeich. Beobach. Säug. N. A. 1860.
H. ALLEN. Monog. N. A. Bats, 1864.

This is our commonest species and is familar to every one. The body is very compact and the fur dense and soft. The head is mouse-like, and expression hightened by the long, rather acute ears.

Color above, dark olive brown, tips of hairs being yellowish: below, olive gray, vared with whitish and yellowish. Lips, muzzle and top of nose nearly naked, vibrissæ abundant, cheeks warty. The membranes are black, the interfemoral portions being slightly hairy. Ear elongated, sub acute; tragus one-half its hight. The point of the tail is exserted.

Dentition *i.* $\frac{2}{3}$, *c.* $\frac{1}{1}$, *m.* $\frac{6}{6}$x2=38. Incisors of upper jaw in pairs projecting inward, small, bifid. Two anterior premolars minute. the second being smaller.

Incisors of the lower jaw, trifid;two anterior premolars very small, the third slender.

Length to anus, 1.8; tail, 1.5;head, nearly 0.7; ear (measured from base of opening) 0.6; (from base behind), 0.45; tragus, 0.3; nose to eye, 0.3; width of gape, 0.3; distance between nares, 0.1; humeral part of arm, 0.9; radius, 1.5; thumb, 0.3; first finger, 1.4; second finger, 2.4; third finger, 2.0; fourth finger, 1.9; expanse, over 8.0; thigh, 0.5; tibia, 0.75.

Toes nearly equal, with short claws, slightly webbed, sparsely hairy on the back.

CHAPTER III.

ORDER INSECTIVORA.

MOLES AND SHREWS.

FIG. 2. *Macroscelides typicus*, an insectivorous animal from Africa.

In this group we have not only the smallest but the oldest of placental mammals and those, for many reasons, particularly interesting to naturalists. Our most familiar representatives of the Insectivora are very mouse-like in appearance and to the natural association so brought about is due the persistent and reasonless persecution which they suffer at the hands of the farmer. The external resemblance is in this case, as so often, quite misleading. In habits and structure the Insectivora are more like bats than the mice.

In the words of Carl Vogt, "One may, indeed, say with truth that they continue on and under the earth, yes, and even in the water, the persistent hunt for insects, snails, and all possible vermin begun by the bats in the air." The largest animal of the group is little larger than a squirrel while the external form varies greatly. Some species are adapted solely to a subterranean existence, and by the great development of the anterior extremities and the reduction of the sense of vision are

unfitted for any other life; others climb freely like squirrels; again others pass much of their time in the water, and exhibit consequent changes in structure; while still other species have the elongated hind legs of the deer mice, and are truly terrestrial. Organs of sense vary in accordance with the requirements of these various situations. The brain indicates a lower condition of the nervous system than in any other group of placental mammals. The hemispheres do not cover the cerebellum nor even the corpus bigeminum. The simple structure of the brain corresponds to an incompletely developed braincase, for not only is the zygoma often entirely absent, but the orbit is never closed, and the whole configuration of the skull is upon a primitive type.

The dentition corresponds to no other group, neither do the different genera conform to any common formula. The canines are absent (save in one case) or are replaced by teeth which have no resemblance to the canines of other animals. Their place is frequently taken by a pair of the incisors. Anatomists are not agreed as to the homologies of the various teeth. Following the incisors are premolars with pointed crowns, and following them square crowned molars, which are also armed with from three to four saliences. The dentition is well adapted to the catching and comminution of insects and crustacea.

The oldest known fossil mammals (from the Triassic) had a dentition resembling the Insectivora and, although they may have been insectivorous marsupials, the suggestion lies near that our present Insectivora are descendants, very little altered, of a very numerous group which early separated from the common mammalian stem. Undoubted remains of insectivorous animals occur in the Eocene of America and France, and thence onward continue to appear with more and more definite affinities to existing forms.

The geographical distribution confirms the indications of paleontology. The group is widely distributed, but is nevertheless absent from South America (or nearly so) and also from Australia. Each principal continent has its endemic types (families or genera), and even Madagascar has its peculiar forms. The Antilles also have their own family of Insectivora. Again Europe and Asia support the hedge-hog family, which is entirely excluded from America. In the two continents rich in marsupials (Australia and South America), there are as yet no Insectivora. In places which have been long isolated (Madagascar and the Antilles), special types have grown up, while

upon the larger continents the differentiation has been less one-sided. Paleontology also shows that the various families of Insectivora early became distinct.

The families are at present, therefore, remarkably compact and sharply defined. Some of the largest species are found in the Indian family *Tupaiidæ*. These animals resemble squirrels in outward form and size and climb well, searching for insects in their leafy retreats. The snout is long and shrew like, but the eyes are more highly developed than in most Insectivora.

The *Macroscelidæ* (see fig. 2) are deceptively like the kangaroo mice. These jumping shrews inhabit sandy and rocky wastes of Africa, and not only root among the rocks for larvæ but even spring after flying sorts with great accuracy.

The *Myogalidæ* are aquatic Insectivora. The various species live in the rivers of eastern Europe, of Asia and parts of Africa. Leeches, fresh water mollusks, and larvæ as well as possibly the fry of fishes, serve Myogale for food. Anal glands give to these animals a most offensive odor.

The *Soricidæ* (shrews) include mouse-like species which may be considered as the type of the Insectivora. Their geographical distribution is most extensive among the families of this group and together with the moles (*Talpidæ*) form the only families found in North America.

Madagascar furnishes a family of Insectivora somewhat like the hedge-hogs but uniting with this habitus characters of the shrews and jumping shrews. *Centetidæ*, as the family is called, contains two genera of similar character. The true hedge-hogs (*Erinaceidæ*) occupy parts of the old world. It is very common to hear our rodent porcupines called hedge-hogs. The two animals have nothing in common but the spiny armature. The hedge-hog is very useful to the European farmer on account of the constant war he wages with rats and mice, which, in spite of seeming awkwardness he skillfully captures. Birds' nests and fruit trees form a secondary recourse. They may be easily domesticated to a certain extent and yet could hardly be considered desirable pets.

The subterranean Insectivora fall into two related families, the one represented by the blind mole (*Chrysochloris*) of South Africa, the other by our familiar moles. The *Talpidæ* of America belong to different genera from the European but are nevertheless very familiar.

The present state of our knowledge of the Insectivora is very low, for the attempts to distinguish species upon variable

superficial characters with no reference to tangible anatomical distinctions has multiplied synonyms to such an extent that no person can ever disentangle the synonomy. At present we can form only very vague ideas as to the actual number of species in several genera. As far as the systematic study is concerned, all that has thus far been written is so much profitless lumber and might best be ignored. Facts regarding the habits, anatmy and geographical distribution, on the other hand, are of permanent and immediate value.

In November, 1883, the writer lay encamped under the canopy of the sky in Pine Co., Minnesota, endeavoring to escape the chill of the frosty air by drawing the blanket close and hovering nearer the camp fire. To a person alone in the woods for the first time after a long interval every sound is novel and more or less charged with mystery. The wind stirred the tree tops and impinging boughs clattered and the trunks groaned under the tortion, each tree with its own doleful note. The few remaining pines added their sighing to the many melancholy sounds belonging to an autumn forest at night. But amid all the sounds nothing could be identified as coming from anything living, even the distant howling of wolves was silenced, and I began to feel that the attempt to gain personal knowledge of the ways of woodsy mammals by night study would prove futile, and composed myself to sleep. The half-somnolent revery which forms the prelude to slumber, was broken by faint melodious sounds on an excessively high key—so high that it seemed that I might be simply hearing the lower notes of an elfin symphony the upper registers in which were beyond the powers of human ears to distinguish. The sounds were distinctly musical and reminded me of the contented twitter of birds finding resting places among the boughs at night. Without moving I turned my eyes upon the fire-lit circle, about which the darkness formed an apparently impentrable wall. Only the most careful scrutiny enabled me to discover the tiny musicians. Within a few feet of my head, upon a decayed log, raced a pair of shrews (*S. cooperi*), so minute as to escape my observation at first. Up and down with the most sprightly imaginable motions they ran, twittering incessantly. Hither and thither they scampered over my clothing and almost into my pockets, like veritable lilliputians, siezing now a crumb of cheese, with which my traps were baited, and now a bit of fish fallen from my improvised supper table. During the eating the conversation was not interrupted. The little

visitors were not bashful about criticising the housekeeping of their host, if their apparent amusement can thus be interpreted, but it was a most good humored little party nevertheless which thus unceremoniously ransacked my larder. The party increased in numbers and merriment, until I was almost forced to believe myself an uninvited guest within the magic circle of Queen Mab's domain. I watched with interest the result of their intrusion into the traps which stood about for the capture of any red-backed mouse that might invade my camp, but Sorex passed entirely within, and daintily arching his back contentedly nibbled the cheese, and when the spring rose usually suffered but a short fright, and returned to finish the interrupted meal. Canned fish seemed to be more acceptable than any other food I had to offer. Tiring of the watching, I again lay down to sleep, during which time elfin voices sounded in my dreams. About midnight one of the little imps sprang across my face in so violent a way as to partially waken me, and thus, as good fortune had it, I was awake sufficiently to recognize the meaning of a sharp crack overhead and sprang out of my bed in time to see it occupied by a massive tree-trunk which the fire had burned off not far from the ground.

The short-tailed shrew was seen during the progress of these investigations but seldom. While riding through a densely wooded portion of northwestern Hennepin county, near lake Independence, a small animal was seen running in an uncertain way across the road ; a hasty pursuit resulted in its capture, although in an imperfect condition. It thus seems certain that this shrew is not strictly nocturnal. The same is true of the smaller shrews. They seem to rely more largely upon the sense of smell than that of vision, and are measurably independent of light in carrying on their search for insects. The smaller shrews were formerly abundant about Minneapolis, and their runways under the slight crust of a new snow, were everywhere encountered. It is certain that they endure the rigors of our severe winters well. Of late we have been unable to secure many specimens, perhaps owing to the abundance of cats, which, I dare say, do not make any fine zoological distinctions before dinner.

In the American Naturalist (vol. vii, p. 483), Mr. G. Linceum gives a graphic account of the habits of a species of Sorex from Long Point, Texas, a part of which I quote :

"They dwell in warm nests made of grass, about the fences or edges of the prairie. They do not come about houses, and

are purely nocturnal. I have found only three nests of them. They have four young at a time, which they nurse and care for most affectionately. I had a family of them and fed them a week where I could observe all their actions. I had a father and mother and their half grown offspring. The male made his escape, and finding a newly married pair—they do marry, and as far as I can learn, stick together as long ss they live—I put them in a box with my half civilized family. The male instantly caught a young one and was aiming to kill it, when I put him and his companion into an empty oyster can, and setting it back in the box, went to supper. When I returned I found that the ferocious, rascally male had made shift to get out of the can, and had murdered all the young ones."

*Family SORICIDÆ.

Animals intermediate betweens the moles and hedge-hogs, and characterized by attenuated movable snout, plantigrade, hairless soles, abscence of zygoma, and imperfect auditory cap-

*The following brief review of the described species may assist the student in securing a fuller knowledge of the groups than can be given here.

1. *Genus Gymnura.* A single species (*G. rafflesii*) is as large as a large squirrel, and has a long snout, short tail and small ears, retractile claws and wooly hair. This interesting species inhabits the Sunda and adjacent islands.
2. *Genus Pardoxodon* is represented by a pigmy, not two inches long, from Bengal.
3. *Genus Pachyura.* A large genus of shrew-like animals, some of which are over ten inches long, others less than two, living in India, southern Europe, Madagascar and Egypt. Specimens of the Egyptian species have been found mummied in the tombs. Nearly thirty species have been described, many of which are synonyms.
4. *Genus Crocidura.* Some twenty-five nominal species are distributed from the cape of Good Hope to India, Ceylon and Japan. *C. aranea* is a common species in Europe, often entering houses, and having much the aspect of a small mouse.
5. *Genus Diplomesodon.* A single species of minute size and peculiar coloration, inhabits the sandy steppes of Kirgisen.
6. *Genus Feroculus.* A somewhat doubtful genus, founded on a single collection made in Ceylon, and intermediate between *Crocidura* and *Myosorex.*
7. *Genus Mysorex.* Small shrews, with the ears entirely concealed, living in South Africa.
8. *Genus Sorex.* The type of the family is found in Europe and America, though it is customary to separate the species into subgenera, or even different genera, to correspond with the difference in habitat. The genus seems, however, to be circumpolar.
9. *Genus Blarina.* North American, with but one well authenticated species, though many have been found.
10. *Genus Soriculus.* A single Indian species, with but thirty teeth.
11. *Genus Crossopus.* This genus of aquatic shrews is circumpolar, although the North American species has been separated as a distinct genus, *Neosorex.* Two or more extremely variable species are rather common in Europe, and others in Asia to Japan.
12. *Genus Solenodon* contains the curious rat-like *S. paradoxus* of Cuba.
13. *Genus Myogale* contains aquatic forms, with vertically flattened tails. Some species are upwards of ten inches long, with a tail nearly as long again. Europe and Asia are the habitat of these musk-shrews.

Since writing the above a new genus and species of shrew has been brought to our notice by C. Hart Merriam: *Genus atophyrax. A. bendirii* Mer. is from Klamath

suli. A peculiar musky fluid is secreted especially during the rut. The eyes are small but functional, and the other senses acute. The voice is pitched upon a high key, but musical.

GENUS BLARINA.

Shrews of a dark color and mole-like pelage, the tail being short and hairy.

Dentition: i, $\frac{1}{1}$, c. $\frac{0}{0}$, pm. $\frac{5}{2}$, m. $\frac{4}{3}\times2=32$, (adult), or i, $\frac{1}{1}$, c. $\frac{0}{0}$, pm. $\frac{4}{2}$, m. $\frac{4}{3}\times2=30$ (immature.)

Blarina brevicaudata SAY.

THE SHORT-TAILED SHREW.

Sorex brevicaudatus SAY. Long's Expedition, I, p. 164, 1823.
HHRLAN. Fauna Amer., p. 29, 1825.
ISID. GEOFFROY. Dict. Class. V, XI, p. 320.
GODMAN. Am. Nat. Hist., I, 1831.
FISCHER. Synopsis Mam., p. 255.
BACHMAN. Jour. Phil. Acad., VII, 1837.
EMMONS. Quad. Mass., p. 13, 1840.
AUD. and BACH. Quad. N. A., V. III, p. 335.
DEKAY. Zool. N. York, V, I, p. 18. 1842.
WAGNER. Schreber Säugethiere, Suppl.
LINSLEY. Am. Journ. Sci., XLIII, 1842.
THOMPSON. Hist. Vermont, 1842.
PLUMBER. Am. Journ. Sci., XLVI.
Blarina brevicaudata BAIRD. Mam. N. A., 1837.
SAMUELS. Agr. Mass., 1861.
Brachyosorex brevicaudatus DUVERN. GUERM. Mag. d. Zool., 1842.
WAGNER. Schreb. Säuget., Suppl.
FITZINGER. Kritische Untersuchungen, Sitzb. d. k. Akad., 1868.
Sorex talpoides GAPPER. Zool. Journ. V, 1830.
REICHENB. Naturg. Raubth.
GIEBEL. Säugethiere.
WAGNER. Schreber Säugeth., Suppl. II.
Corsira talpoides GRAY. Proc Zool. Soc. Lond., 1837.
Blarina talpoides BAIRD. Mam. N. A.
GRAY. Proc. Zool. Soc Lond., 1837.
SAMUELS. Agr. Mass., 1861.
VERRILL. Proc. Bost. Soc. Nat. Hist., 1863.
Amphisorex talpoides GIEBEL. Säugethiere, p. 901.

Basin Ore., and seems to be paludial in habit. It possesses characters allying it with *Neosorex*, but it agrees with *Sorex* in the number of teeth. The only known species is one of the largest of the true American shrews. (See Trans. Linnæan Society of N. Y., vol. ii, 1884.)

Sorex parvus SAY. Long's Expedition, I.
HARLAN. Fauna Amer.
BACHMAN. Journ. Phila. Acad. Nat. Sci., VII.
LINSLEY. Am. Journ. Sci , XLIII.
FISCHER. Synopsis Mam.
RICHARDS. Fauna Bor. Amer.
WAGNER. Schreber Säugeth.
REICHENB. Naturg. Raubth.
DE KAY. Fauna, N. Y.
AUD. and BACH. Quad. N. A.
Brachyosorex parvus WAGNER. Schreb, Säugeth.
FITZINGER. Kritische Untersuch.
Sorex dekayi BACHMAN. Journ. Phila. Acad. Nat. Sci., VII.
DE KAY. Fauna, N. Y.
LINSLEY. Am. Journ. Sci. XXXIX.
REICHENB. Naturg. Raubth.
AUD. and BACH., Quad. N. A.
WAGNER. Schreber Säugeth.
Brachyosorex dekayi WAGNER. Schreber Säugeth.
FITZINGER. Kritische Untersuch.
Sorex cinereus BACHMAN. Journ. Acad. Phila. VII.
REICHENB. Naturg. Raubth.
DE KAY. Zool. of N. Y.
WAGNER. Schreb. Säugeth.
Crocidura cinerea REICHENR. Naturg. Raubth.
Blarina cinerea BAIRD. Mam. N. A.
Blarina carolinensis BAIRD. Mam. N. A.
Blarina angusticeps BAIRD. Mam. N. A.
Blarina exilipes BAIRD. Mam. N. A.
Blarina berlandieri BAIRD. Mam. N. A.

FIG. 3. BLARINA BREVICAUDATA.

It will be seen from the above table of synonymy that the writer fully coincides with the opinion, expressed by Mr. J. A. Allen, in his paper on the Mammalia of Massachusetts (Bul. No. 8. Mus. Comp. Zool., Cambridge), that there is no evidence

of the existence of more than a single species of *Blarina* It seems, on the other hand, very probable that there is but one somewhat variable species, extending from the Atlantic to the Pacific, and from Mexico to northern Canada and Behring's straits. This species is moderately abundant about Minneapolis.

The following measurements may be taken as indicating the average size : Body and head, 3.50 ; tail, .85—1.00 ; hind foot, .64 ; fore foot, .44. A male, somewhat larger, had a tail measuring 1.08 ; the hind foot, .65 ; nose to eye, .50 ; nose to tip of incisors, .30.

The short-tailed shrews are more mole-like in appearance than the smaller species, both on account of their low form and short tail, and the dark mole-like pelage. The color is dark plumbeous above, with a somewhat glossy reflection. The hairs are fine. The lower parts are lighter and with rusty or rufous gloss. The whiskers are numerous, fine and light-colored. The head is rather stout and short, and in this respect differs to a marked degree from the smaller shrews. The head is also much depressed, and the eyes lie nearly half way between the muzzle and the back of the head. The muzzle is not nearly as long as in *Sorex*, and is truncated and naked with the nostrils opening on the sides. The ear is not seen in life, although it is large, because the meatus is closed by the auricle. The antitragus and antihelix are well developed and valvular. The palm has five callosities, the sole six. The tail is constricted at the base, and expands suddenly, after which it is of uniform size until near the end ; it is but moderately hairy, although bearing a considerable pencil at the tip. The upper surface of the feet is minutely hairy. The third toe is longest.

It would perhaps be expected that the size of southern specimens would be less than those farther north, and this may explain "*B. carolinensis*" of authors, in the specific characters of which the only tangible point seems to be the inferior size. *B. angusticeps* must be regarded, until farther information is obtained, as an illustration of an extreme instance of individual variation, such as may be occasionally met with in any species.

The specimen figured above was obtained in Ohio, March 4th, and is one of several seen at about the same time. The measurements are as follows :

Length of body, 3.1 ; tail, 0.9 ; total, 4.0 ; hind foot, 0.48 ; fore foot, 0.39 ; nose to eye, 0.41 ; nose to ear, 0.80 ; vibrissæ, 0.70.

Color uniform plumbeous black, without gloss, but perfectly dead and homogeneous everywhere except upon the feet, which

are reddish brown. Tail nearly glabrous at the base, but terminating in a considerable pencil of hairs. First and fifth toes of fore foot as are the second and fourth, these being much longer than the former, third toe longest. Claws of the fore foot much longer than those of hind foot. Hind foot broad, fifth toe somewhat longer than first; second, third and fourth toes subequal.

When captured the shrews are very likely to be devoured by their companions, and it is frequently very difficult to secure unmutilated specimens on this account. Dr. Merriam gives the results of experiments upon the present species, as follows:

"Having caught a vigorous though undersized shrew, I put him in a large wooden box, and provided him with an ample supply of beechnuts, which he ate greedily. He was also furnished with a saucer of water, from which he frequently drank. After he had remained two days in these quarters, I placed in the box with him an uninjured and very active white-footed mouse. The shrew at the time weighed 10.20 grammes, while the mouse, which was a large adult male, weighed just 17 grammes. No sooner did the shrew become aware of the presence of the mouse than he gave chase. The mouse, though much larger than the shrew, showed no disposition to fight, and his superior agility enabled him, for a long time, easily to evade his pursuer, for at a single leap he would pass over the latter's head and to a considerable distance beyond. The shrew labored under a great disadvantage, not only from his inability to keep pace with the mouse, but also to a still greater extent, from his defective eyesight. He frequently passed within two inches (31 mm.) of the mouse without knowing his whereabouts. But he was persistent, and explored over and over again every part of the box, constantly putting the mouse to flight. Indeed, it was by sheer perseverance that he so harassed the mouse that the latter, fatigued by almost continuous exertion, and also probably weakened by fright, was no longer able to escape. He was first caught by the tail; this proved a temporary stimulant, and he bounded several times across the box, dragging his adversary with him. The shrew did not seem in the least disconcerted at thus being harshly jerked about his domicile, but continued his pursuit with great determination. He next seized the mouse in its side, which resulted in a rough and tumble, the two rolling over and over and biting each other with much energy. The mouse freed himself, but was so exhausted that the shrew had no difficulty

in keeping alongside, and soon had him by the ear. The mouse rolled and kicked and scratched and bit, but to no avail. The shrew was evidently much pleased, and forthwith began to devour the ear. When he had it about half eaten off the mouse again tore himself free; but his inveterate little foe did not suffer him to escape. This time the shrew clambered up over his back, and was soon at work consuming the remainder of the ear. This being satisfactorily accomplished, he continued to push on in the same direction, till he had cut through the skull, and eaten the brains, together with the whole side of the head and part of the shoulder. This completed his first meal. As soon as he had finished eating I placed him upon the scales, and found that he weighed exactly 12 grammes—an increase of .80 gramme."

Sorex cooperi BACHMAN.

COOPER'S SHREW.

Sorex cooperi BACHMAN. Journ. Acad. Sci., Phila. VII.
REICHENB. Naturg. Raubth.
DE KAY. Zool. of N. Y.
AUD. and BACH. Quad. N. A.
WAGNER. Schreber Säugeth. B. V. Suppl.
BAIRD. Mam. N. A.
FITZINGER. Kritische Untersuch.
ALLEN. Bull. Mus. Comp. Zool., No. 8.
Crocidura cooperi REICHENB. Naturg. Raubth.
Amphisorex lesueri DUVERNOY. Mag. de Zool., 1842.
Sorex lesueri WAGNER. Suppl. Schreber. Säugeth. V.

Although the synonyms quoted above, refer to the western form, which constitutes the species in its strictest sense, as understood by Prof. Baird, the author is greatly inclined to believe that at least *S. haydeni*, and probably several other species given in the mammals of North America, are really varieties of the present species. Not having material for comparison of this with the other species of the genus, we must content ourselves with a brief description of the only Sorex yet encountered in Minnesota. The specimens examined in Minnesota were remarkably uniform in size. Average measurements are as follows: Length, 3.50; tail, 1.72; head and body, 1.78; hind foot, about 0.50.

Sorex platyrhinus, the common eastern species, has not been detected in Minnesota.

Neosorex palustris is an aquatic species found rarely in New England, which may be expected here. I have noticed on several occasions burrows and tracks leading to the water's edge, with small gasteropod mollusk shells scattered about in such a way as to lead one to suspect the presence of an aquatic insectivorous animal, but all efforts failed to secure specimens.

Family TALPIDÆ, Moles.

The moles proper are easily distinguished, and constitute a natural and compact group. The genera are few and widely distributed, and although a rather large number of nominal species have been formed on superficial characters, the variability is sufficient to reduce them to very few distinct specific types. It is strange that naturalists should be surprised to find in animals only rarely seen, and then under exceptional conditions, the same variation which is everywhere observed in our familiar species, and yet every slight variation in color and proportions, has been seized as a reason for creating a new species in this family.

In appearance the moles resemble the shrews in several respects, but there could hardly be found a more striking diversity of habit than that furnished by the active, vivacious, social and terrestrial shrew, and the clumsy fossorial hermit whose disposition seems as crabbed as any one's should be, immured by caprice in damp, endless labyrinths.

The head is very large and elongated, terminating in a slender, generally flattened proboscis, in which the nostrils open upward. The eyes are minute, and are either concealed in the pelage or are entirely covered by the skin. The shoulder is enormously developed, while the arm is greatly shortened and bears an enormous shovel-shaped, five-toed manus, set at right angles to the axis of the body, so as to play laterally in pushing the earth aside. The posterior part of the body is comparatively weak, and the hind feet and tail small, the latter usually naked. Moles are entirely insectivorous, and, except for the unsightly mounds sometimes made, and the persistency with which they at times mine in cultivated ground, should rank as true aids to the gardener. A deep seated prejudice against them existed from early times, and in the early days of Europe an official mole catcher formed one of the stipendiaries of a well equipped manor. Moles were thought to have something

uncanny about them, and figured to a greater or less extent in the witchcraft of the time.

The moles are solitary, except during the breeding season, which is a period of unrest and ceaseless quarrels.

The fact that the genera are restricted to the respective continents where they are found, would seem to indicate that the fossorial habit is a preventive of ready distribution, and that the forms are endemic. South America is without moles, as well as other Insectivora.

The geographical distribution may be gathered from the brief systematic outline given below.*

In the moles the skull is flattened pyriform and shrew-like, but differs obviously in the possession of perfect zygomatic arches and enclosed bony tympanic bulla. There is no distinct post-glenoid process; the cervical vertebræ have no hypaphophyses; sternum with a strongly keeled manubrium; scapula narrow, longer than whole arm; clavicle very short; humerus enormously enlarged; carpus with an os intermedium, and (usually) a sickle-shaped osseous support to hand. The hind limb is weak.

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*1. GENUS UROTRICHUS.

A single Japanese and Asian species, *U. talpoides*, represents a genus having the general characters of the moles, except a slender terete snout and a slender bristled tail. The dentition is $\frac{2}{2}, \frac{0}{0}, \frac{3}{4}, \frac{3}{3} \times 2 = 36$. This is thought to form a transition toward *Myogale*.

2. GENUS CONDYLURA.

See above. Fitzinger in the face of the unanimous authority of recent American writers, recognizes four species on the basis of seasonal and sexual modification.

3. GENUS SCALOPS.

Also see above. A North American genus, with perhaps two closely allied species, out of which Fitzinger forms nine. The calm indifference with which a European author settles a question of specific validity upon the evidence of fragmentary, conflicting descriptions by hasty European travelers, with the possible help of mouldy, ill-stuffed skins of doubtful authenticity, in the face of American students, with large accumulations of material, would be amusing if not more.

4. GENUS TALPA.

Fitzinger recognizes seven species of this genus, whose type is the common mole of Europe, *Talpa europæa*.

Five named varieties of the common mole indicate how variable such a species may be, and affords a suggestive commentary on the numerous species of Scalops recognized.

Talpa cæca differs from *T. europæa* simply in the size of the eye orifice, and is usually considered identical with it. Two species of this genus are accredited to America almost certainly erroneously, they are *T. nigrofusca* and *T. reposta*. A Japanese species, *T. wogura*, was secured by Temminck, and an East Indian, *T. micrura*, by Hodgson, while a very doubtful species, *T leucura* Blyth, was described by Blyth from farther India. It is probably simply *T. micrura*.

5. GENUS CHRYSOCHLORIS.

The golden moles of Africa differ from the above in having but four toes on the fore foot, and lacking the tail.

Of this genus there seems to be three or more species; Fitzinger enumerates nine.

C. inaurata (or *C capensis*, as it is perhaps properly called) occurs at the cape of Good Hope.

C. obtusirostris is from near Mosambique.

C. villosa from Port Natal, was first described by A. Smith in 1833, and specimens are in the British Museum.

6. GENUS SCAPHANUS.

This genus is closely related with Scalops, differing in dentition and the possession of a hairy tail. The single species, *Scapanus breweri*, is found in the eastern United States.

GENUS SCALOPS. CUV.

This genus includes American moles, in which the nostrils are on the upper surface of the nose, and are not surrounded by fringing tentacles, and the teeth are 36 in number, the two upper anterior ones being very large.

Fig. 4. SCALOPS AQUATICUS.

Scalops aquaticus LINN. SP.

Sorex aquaticus LINN. Syst. Nat., 1758.
ERXLEBEN. Syst. Reg. Anim., 1771.
SCHREBER. Säuget., iii.
BODDAERT. Elenchus Anim, 1784.
GMELIN. Syst. Nat., 1788.
Talpa europea flavescens ERXLEBEN. Syst. Reg. Anin., 1777.
ZIMMERMAN. Geogr. Geschicte d. Menschen u. d. Thiere.
SCHREBER. Säugethiere.

Talpa virginianus niger. SEBA. Thesaur.
Talpa virginiana BRISSON. Régne anim.
Talpa rubra ERXLEBEN. Syst. regn. anim.
Talpa fusca SHAW. Gen. Zool.
Talpa purpurascens SHAW. Gen. Zool.
Talpa vulgaris var B. BODDAERT. Elencn. Anim.
Talpa pennantii LECONTE. Proc. Acad Phila., V.

A

B

Figs. 5 and 6.

A Upper surface of hand. *B* Upper surface of snout.

Talpa latimanus LECONTE. Proc. Acad. Phila.
(?) *Tlapa townsendii* LECONTE. Proc. Acad. Phila.
Talpa aquatica LECONTE. Proc. Acad. Phila.
Talpa ænea LECONTE. Proc. Acad. Phila.
Scalops aquaticus CUV.
ILLIGER. Prodrom.
FISCHER. Synops. Mam.
WAGNER. Syst. d. Amph.
BACHMAN. Journ. Acad. Phila.
WAGNER. Schreber Säugethiere.
GRAY. Mam. Brit. Mus.
REICHENBACH. Naturgeschicte Raubthiere.
BLAINVILLE. Osteograph, Insectiv.
DEKAY. Zool. N. Y.
AUDUBON and BACHMAN. Quadr. N. A.
GIEBEL. Säugethiere.
BAIRD. Mam. N. A.
FITZINGER. Naturliche Fam. d. Maulwürfe.
ALLEN. Mam. Mass.
BRAYTON. Mam. Ohio.

Scalops canadensis F. CUV. Dict. des Sc. Nat.
DESMAREST. Nouv. Dict. Nat. Hist.
HARLAN. Fauna Americana.
GRIFFITH. Anim. King.
RICHARDS. Fauna Bor. Am.
EMMONS. Zool. N. Y.
Scalops latimanus BACHMAN. Journ. Acad. Phila.
REICHENBACH. Naturg. Raubt.
AUDUBON and BACHMAN. Quad. N. A.
WAGNER. Schreber's Säugeth.
Scalops pennsylvanica HARLAN. Fauna Amer.
FISCHER. Synopsis Mam.
WAGNER. Schreber's Säugeth.
? *Scalops æneus* CASSIN. Proc. Acad. Phila.
WAGNER. Schreber's Säugeth.

The above synonymy is not vouched for entirely, much of it being collected from various works. It serves to show how numerous have been the notices of this animal, and yet how little has been added to our knowledge of its habits, variations and anatomy.

The following measurements indicate the average size: Nose to anus, 4.6; tail, 1.4; total length, 6; nose to incisors, 0.5; nose to ear, 1.35; nose to occiput, 2.0; length of fore foot, 0.9; width, 0.85; length of hind foot, 0.9. Additional measurements of the same specimen may be taken from the figure of the skeleton. Color deep brown to plumbeous, with a yellowish reflection; fur moderately long and fine. Tail almost naked. Snout long, flattened, obliquely truncate, bearing the nostrils on the upper and outer surface, inclined toward each other. Fore foot greatly enlarged, both by the lateral separation of the fingers, which are fully webbed, and by the addition of a wide blade supported by a specially developed sickle-shaped bone of the wrist. (See fig. 4 and figs. 6 A and B.) The ear is very minute and entirely without an external appendage; the eye is concealed under the skin, and lies but little back of the angle of the mouth.

The mole may be almost said to swim through the earth, its feet not being beneath the body, but on either side, and so armed with broad spade-like claws, and so highly provided with muscles as to glide rapidly through the soft earth. During the passage through the earth, the back and shoulders wedge the earth upward, so that the course of the animal can be followed by the observer above. During its passage the highly sensitive and vibratile snout is constantly in motion, searching for such insects, worms, etc., as may come in its

way. It seems hardly likely that this organ really assists materially in loosening or removing the soil, as some have thought. Advantage is taken of the upward thrust of the earth to place dead-falls over their runways, in such a way that the passage of the animal shall cause a weighted and armed board to descend and transfix the animal. Little is known of the domestic economy of the mole. It rarely leaves the earth on dark days, though it has been seen in the streets of a large city, wandering aimlessly. The males are said to be very pugnacious, and live apart during most of the year. Two litters of from five to nine young may be produced annually. The nest is found in sheltered situations, and is composed of grass and leaves. The complicated system of galleries produced by Talpa is not ascribed to our species.

Scalops (aquaticus VAR.) argentatus AUD. and BACH.

Scalops argentatus BACHMAN. Journ. Acad. Phila.
AUDUBON and BACHMAN. Quad. N. A.
REICHENBACH. Naturg. Raubt.
WAGNER. Schreber's Säugeth.
BAIRD. Nam. N. A.
FITZINGER. Naturlich. Fam. Waulwürfe.
JORDAN. Mam. Vertebrates.
KENNICOTT. Pat. Of. Rep. Agr., 1857.
Scalops aquaticus GIEBEL. Säugeth.
Scalops aquaticus var. argentatus COUES. [?]
BRAYTON. Mam. Ohio.

Although this is the common form in Minnesota, the writer has had no opportunity to compare the anatomy with *S. aquaticus.* In all probability it should stand as a well marked geographical variety, conspicuous for its light colored silvery fur, which is very long, fluffy and soft. It averages somewhat larger than the common mole; other differences seem to be intangible. It is difficult to conceive of a more beautiful pelage than that of this mole, the individual hairs being as fine and so peculiarly formed as to give rise to a gorgeous play of colors, due to interference of the rays of light reflected. This species occurs in Ohio, and extends westward, throughout the prairie region.

Mr. Weber says: "Two moles in nine days ate 341 white worms, 193 earth worms, 25 caterpillars, and a mouse, both the bones and skin of which they swallowed." An idea that the mole is possessed of an unusually keen sense of hearing seems

to be indicated by the expression in Shakespeare: "Pray you tread softly, that the blind mole may not hear a foot-fall."

GENUS SCAPHANUS.

Dentition: i. $\frac{3}{3}$. c. $\frac{1}{1}$, pm. $\frac{4}{4}$, m. $\frac{3}{3}\times2=44$. The teeth forward of the last premolar are nearly equal in size above and below. Nostrils lateral or superior. Tail hairy.

Scaphanus breweri is not known to occur in Minnesota, but since another closely allied form, *S. townsendi*, occurs in Oregon, it is not unnatural to expect that some representative of the genus will ultimately be found.

Condylura cristata L. (DESM.)

STAR-NOSED MOLE.

Sorex cristatus LINNÆUS. Sys. Nat. (Ed. X), 1758.
ERXLEBEN. Syst. Reg. Animal, 1777.
SCHREBER. Säugeth, 1784.
BODDÆRT. Elenchus Anim., 1784.
GMELIN. Syst. Nat., 1788.
Condylura cristata DESMAREST. Journ. de Physique, 1819.
HARLAN. Fauna Am., 1825.
GODMAN. Journ. Acad. Nat. Sci. Phila., 1825.
GRIFFITH. Cuv. An. King, 1827.
DE KAY. Zool. of N. Y., 1842.
BAIRD. Mam. N. A., 1857.
MERRIAM. Mam. Adirondacks.
Rhinaster cristatus WAGNER. Suppl. Shreb. Säuget., 1841.
Talpa longicaudata ERXL. Syst. Reg. Anim., 1777.
SHAW. Gen. Zool., 1800.
Talpa radiata SHAW. Gen. Zool., 1800.
Sorex radiatus SHAW. Gen. Zool., 1800.
Condylura longicaudata DESMAREST. Mamm., 1820.
HARLAN. Fauna Am., 1825.
GRIFFITH. Cuv., 1827.
RICHARDSON. Fauna Bor. Am., 1829.
FISCHER. Synopsis, 1829.
GIEBEL. Säugeth., 1855.
Rhinaster longicaudata WAGNER. Suppl. Schreb., 1841.
Talpa longicaudata BODD. Elench. Anim., 1784.
Condylura macroura HARLAN. Fauna Am., 1825.
RICHARDS. Fauna bor. Amer.
FISCHER. Synop. Mam.
GIEBEL. Säugethiere.
REICHENBACH. Naturg. Raubth.
Rhinaster macrurus FITZINGER. Naturl. Fam. Maulw.
Condylura prasinata HARRIS, GODMAN, LESSON, WAGNER.
Astromycetes cristatus GRAY. Etc., etc.

Only a partial synonomy is given, but enough to indicate the attention which this strange species has received at the hands of naturalists. Although probably measurably common, this species is very rarely seen. Only one specimen was secured during the progress of the survey, and the Indian who secured it stated that it was the first one he had seen, although he evinced great familiarity with even the smaller animals.

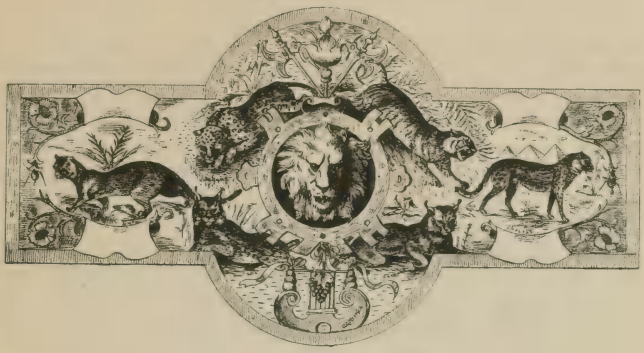
The specimen, a male with thickened tall, measured as follows: Length to tail, $4\frac{5}{16}$; tail, $3\frac{1}{16}$; nose to base of fore foot, $1\frac{3}{4}$; palm, $\frac{3}{4}$; longest fore claw, $\frac{5}{16}$; hind foot, $1\frac{1}{16}$. The color above was black with a shade os vandyke brown, below a just perceptible tinge of reddish brown, with a ferrugineous suffusion. Here and there are rusty splotches, especially under the throat and thighs, tail and feet reddish flesh color; former fusiform, constricted at the base. Claws straw-yellow.

In general form this species closely resembles the common mole, being clumsy, neckless, and with enlarged palms. The snout is thicker than in the mole, and its smooth terminal portion extends into a fimbriated margin; the radiating cartilaginous processes numbering from 20 to 22. These processes are about a quarter of an inch long. The nostrils are terminal and circular and the muzzle is furrowed below. The eyes are small, but distinctly visible, and are midway between the muzzle and the ear. The external ear is limited to two small valve-like flaps. The tail is fusiform, and covered with scales which have an annular arrangement between which are sparse hairs.

The palms are fringed with stiff hair, and the outer edges of the front toes are produced into horny processes.

The star-nosed mole is distributed from the Atlantic to the Pacific in suitable situations, but seems to be most at home between 40° to 45° N. latitude. Moist meadows furnish the conditions best suited to this species, and there it may sometimes be found in considerable numbers in company with Scalops aquaticus, in the habits of which it shares, feeding on grubs and the like. The breeding chamber is placed beneath the protection of a stump, but little is known of the habits.

Osteology: The skull is more slender than in Scalops, and the auditory openings and bullæ resemble the shrews. Dentition $\frac{3}{3}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3} \times 2 = 44$. The upper incisors project horizontally and are approximate; these are followed by a filiform tooth, and this by a canine-like tooth with a small spur posteriorly. After a hiatus comes a small canine.



CHAPTER FOUR.

ORDER CARNIVORA.

FLESH EATERS.

This order is represented within our limits by—species of—genera contained in—distinct families. It deserves to rank as one of the highest, if not the highest order, if specialized differentiation in one direction and within narrow limits are points sufficient to justify the claim. Although actually as a group, of little economic interest, except it be on account of inroads upon domestic animals, no order secures more popular attention and interest than this. Lions and tigers, bears and wolves, these and others are familiar and dreaded names from the nursery. Besides this, the constant and household companions which man has selected from the ranks of the lower animals belong to this order. Domestic cats and dogs introduce to us the larger and more intractible cousins of the wilderness.

In spite of the considerable variation in external appearance exhibited by different members of the order, it is very homo-

geneous in essential characters. From the weasel, to the bear or lion, we may look without finding any animal so peculiar that there is any difficulty in recognizing affinities with its fellows.

The typical carnivore has a more or less triangular head with pointed muzzle, armed with long vibrissæ. The ears are pointed and movable, while the eyes are large, or at least of fair size, (the bears do not conform to this type), and are directed forward. The body is powerful, if not graceful and lithe, as in most cases. Limbs are of moderate length and adapted for progression, (but rarely useful for prehension). The claws are powerful, and in the highest groups retractile, so that the keen points and edges are not worn dull by walking. This is accomplished by the peculiar position of the last bone of the toe. There are usually five toes on each foot and the reduction never affects more than one toe on a foot. Though the bones of the fore arm are not united, they are nevertheless not adapted for rotary motions of pronation, etc., in most groups.

The bears touch the ground with the whole sole of each foot, or are, in other words, plantigrade. Between this condition, and that of the cat, where only the toes touch the ground in walking, or when progression is entirely digitigrade, there is a complete series of intermediate links. The former method is held to be the primitive one for the order and permits of great freedom in the use of the extremities, but it is also accompanied with a certain heaviness and even clumsiness, which is avoided by the digitigrate foot. An animal which must run swiftly, or spring upon its prey from a distance, requires the additional leverage furnished by a long heel.

The brain is well developed, having several convolutions and a large corpus callosum. The cerebral hemispheres do not overlap the cerebellum, however. The development of the organs of sense reaches the maximum in this order. The eyes are usually specially adapted to nocturnal vision, so that, although the contractile iris adjusts the eye to strong daylight, the darkness of night is no obstacle to the chase of prey. The following anatomical characters may be added. The digestive tract is comparatively simple, the stomach never being composed of more than one chamber, and the cœcum, if present, is small. The clavicles are absent or very rudimentary, being most highly developed in the cats. The atlas vertebra has two large transverse processes. The zygomatic arches are usu-

ally very wide and curve upward. The orbit is never set off from the temporal fossa, by the union of the post frontal processes of the temporal and zygomatic bones. There is in almost every case a deciduate, zonary placenta. The dentition is especially characteristic and also difficult to reduce to the same general formula. The dentition of the forepart of the mouth is, indeed, remarkably uniform throughout the group. There are always six incisors in each jaw (except in the single case of the sea otter) and two canines. The incisors are usually chisel-shaped, and are well adapted to gnaw the flesh from bones of their prey. The canines serve an entirely different purpose. They are frequently so long that they lock the jaws when they are closed, and enable the animal to seize its prey with a grip which no efforts will suffice to shake off. The size and form of the canines constitute, to a certain extent, an index of the habits of the animal. The molars and premolars constitute a more or less continuous series of variable number.

The crowns are usually furnished either with sharp cutting edges or conical prominences. As the canines indicate the habits of the animal especially with reference to the way in which they secure their prey, so the molars and premolars furnish good evidence of the sort of food constituting the ordinary diet. The lateral extension of both the condyles and glenoid surfaces, for the lower jaw prevents that lateral motion of the jaws characteristic of herbivorous animals, and in harmony with this fact, the molars do not oppose each other, but the teeth of the lower jaw fit between those above, and, in many cases, their knife-like edges constitute the blades of veritable shears. There are never more than four premolars in one half of the jaw in any living carnivore, and the number may be considerably reduced. One of the premolars above and below is remarkably developed and furnished with two knife-like lobes, and is especially adapted to the cutting of flesh into morsels. These *sectorials* are frequently the largest teeth and are situated so far toward the back of the mouth, that they are very effective on account of the superior leverage their position in the jaw occasions.

The operation of these teeth can be seen when, for instance, a cat in biting off a tough bit turns the head to one side and closing her eyes, gnashes with a sort of fury, cracking even thick bones. Back of these teeth are the true molars which have flatter or tuberculated crowns. In the typical carnivores these are slightly developed, but they keep pace with the development of omnivorous propensities.

According to the dentition, all living and fossil carnivorous animals might be grouped under two types, the one represented by the fossil family *Arctocyonidæ*, and the other by the likewise extinct family *Hyænodontidæ*. The former have the characteristic dentition of omnivorous animals and the latter of carnivores. Both had 44 teeth while the latter had five premolars, the last two of which were sectorial.

The sectorial of the upper jaw is always one of the milk teeth while that of the lower jaw belongs to the permanent series. The variations from the original type which are observed in modern carnivorous animals consist in reduction in the number and various modifications in the form and use of individual teeth. No living carnivore has more than the original number, 44. In the dogs and bears the number is reduced to 42 while the Subursidæ have two less. The badgers have 36; in all these cases, however, the molars exhibit the true omnivorous characters.

The true carnivores, as represented typically by the cats, have only 30 teeth. The animal in this order which possesses the fewest teeth is the Patagonian Lyncodon which has 28, i. e., one premolar less than the cats on either side. Among the fossil cats is an instance of still greater reduction in the Machærodus with its monstrous walrus-like upper canines.

Although, as above said, the dentition affords a basis for sub-dividing the order into two groups it is found convenient to form three sub-orders as follows:

I. Sub-order *Æluroidea* containing the families *Viverridæ* or civet cats, *Hyænidæ* or hyænas, *Cryptoproctidæ* including the Foussa of Madagascar, and *Felidæ*, the cats.

II. Sub-order *Arctoidea* embracing the families *Ursidæ* or bears, and *Mustelidæ* or martins.

III. Sub-order *Cynoidea* embracing the *Canidæ* or dog family.

Suborder ÆLUROIDEA.

The characters upon which this suborder is founded are technical and the real basis for the subdivision is found in similarities of structure and habits which connect the different members of this group more closely with each other than with members of the other suborders. The points usually selected as distinctive are the following: Teeth without tuberculate crowned molars, reduced in number. Auditory bullæ inflated,

rounded and usually septate, the external meatus being short. Paroccipital and mastoid processes not prominent, the latter being sometimes indistinguishable.

The cæcum is small or absent. There are both cowper's and prostrate glands. Of the four families of this sub-order only one, the Felidæ, is represented in Minnesota, and we may here simply pass in review the typical members of the others as introductory to a study of our own Carnivora.

The family *Viverridæ* is restricted to the warmer portions of the old world, one species only occurring in southern Europe. The legs are short and the body usually is almost weasel-like in its slenderness. There may be four or five toes on the feet. Both plantigrade and digitigrate forms occur. In the one case the claws are not retractile, while in the other they are cat-like.

The head is small and narrow on account of the slight arch of the zygoma. The orbit is sometimes closed. The teeth are more or less carnivorous but vary greatly in form. The number of incisors and canines is constant and normal. There are also constantly two molars in each ramus of both jaws. The number of premolars may be three or four and the conformation of the teeth differs in the milk set from that in the permanent dentition. Of the numerous species most are nocturnal and all have a musky smell.

Exceptionally, fruit forms the staple diet but the greater number are entirely carnivorous. Some species, like the ichneumon have been domesticated and prove useful in ridding buildings of vermin.

The genet represents the family in Europe and is a slender yellowish gray animal with black-spotted pelt and long, ringed tail. The Asiatic zibet and the African civet are worthy of note on account of the peculiar secretion of the anal glands known as zibet and which, when mixed with oil, constitutes a perfume-like musk. It is said that both in India and parts of Africa numbers of these animals are kept in confinement and well fed with birds and periodically relieved of the waxy secretion by scraping the sack-like mouth of the glands with a spoon. The two animals resemble each other, the African being larger and reaching the size of a fox.

Prionodon gracilis is a graceful little animal with a spotted coat found upon Java and neighboring islands and feeds entirely upon birds. The coffee cat, *Paradoxurus*, inhabiting eastern India is more omnivorous than the above and feeds

upon sweet vegetables like bananas as well as birds. It is beautifully marbled with black upon a yellow ground. The mampalon which dwells near the fresh waters of Borneo and Sumatra is an abberant form resembling the otter greatly and like it is aquatic, having webbed feet and is partially plantigrade.

The ichneumons have already been referred to and many species are known.

The suricate is a small animal something over a foot long, inhabiting South Africa and remarkable for having but four toes and teeth of an insectivorous type. The food consists of small mammals, birds and insects and the animal is used by the natives, as is the ichneumon elsewhere, to destroy vermin in spite of a strong and to Europeans exceedingly offensive odor. In addition to the above we may mention the mangue, *Cynictis*, the binturong, and *Arctitis*.

The *Hyænidæ*, or hyæna family are a rather small group although it was in the last geological age of relatively greater importance. The living animals of this group are confined to the warm portions of the Eastern Continent and are nocturnal in habit.

The external form is somewhat like that of a wolf but differs especially in the great and disproportionate development of the fore legs. The head is large and the muzzle is short. The pupil is round and the ears pointed. The feet have four toes except in the Aard Vark or Earth Wolf of South Africa which has five on the fore feet. Progression is plantigrade and the claws not retractile. All hyænas have anal glands which emit an unpleasant smell and prevent the domestication of the animal. The lower jaw is very powerful and armed with strong crushing teeth. Their milk and permanent dentition are very different, the following being the formulæ; milk dentition $\frac{3}{3}\cdot\frac{1}{1}\cdot\frac{4}{4}\cdot\frac{0}{0}=32$, permanent detition $\frac{3}{3}\cdot\frac{1}{1}\cdot\frac{4}{3}\cdot\frac{1}{1}$ The dorsal vertebræ number 14 or 15. The *Proteles*, or Aard Vark, differs conspicuously from the true hyaenas especially in possessing small weak teeth. This animal is little known but is very retiring, burrowing with facility and possibly living largely upon insects and reptiles. The milk dentition is of a more carnivorous sort than the permanent set and furnishes evidence that the present anomalous nature of the teeth is due to retrograde development.

A third family the *Cryptoproctidæ*, contains only the genus Cryptoprocta formed to include the Foussa of Madagascar

This animal is interesting not only because it is the sole carnivore of any size found upon Madagascar but because it unites with the form of a civet the dentition found in no living cat, but characteristic of tertiary Felidæ. The body and head are slender, the tail long, and while the claws are retractile, the whole sole is applied to the ground. There are anal glands such as characterize the civets to which and the Felidæ they form a link. The last of the families of the Æluroidea is that containing the cats proper to which we now pass.

FELIDÆ.

THE CAT FAMILY.

This family may be considered the typical and the highest member of the Carnivora. We find in this group only graceful and well-formed animals combining with wonderful strength and agility such variations in form as are best adapted to the special habitat in which the animal is found. The psychical characters agree with the physical and we find in the cats a fine combination of courage and affection. In addition to highly developed senses and mental powers, the cats have a certain spirit of independence which makes them less adapted than the dogs to be the slaves of man. The cat always retains her self esteem, at least so long as she keeps her pelt and feet dry, and wishes to be treated with consideration, in which case she will exhibit all the affection with none of the servility of the dog, as though conscious of royal blood and princely connections. The personal pride which makes the cat so careful not to soil her beautiful fur is seen in all her relations with man. She does not hesitate to take possession of the best place and exacts attention to her kittens with motherly pride, and in return for care and caresses often lays her booty of mice or birds at the feet of the master, perhaps rather as an evidence of service than in the real expectation of their being used. The toes only touch the ground in walking and the hallux is absent, while the thumb is elevated above the other toes. Nearly all the family are furnished with retractile claws which are preserved from dulling by being withdrawn into sheaths during walking. In the living species there is very slight variation from one type of dentition. The formula for the milk dentition is as follows: $\frac{3}{3}:\frac{1}{1}:\frac{3}{2}:\frac{0}{0}=26$ for the permanent set $\frac{3}{3}:\frac{1}{1}:\frac{3}{2}:\frac{1}{1}=30$. The incisors are small, irregularly chisel-shaped

and adapted for gnawing. The canines are long and curved. The first upper pre-molar is small while the third is the sectorial and is the largest tooth, being trenchant with three external cusps and an internal tubercle. The molar is small. The lower molar is the sectorial which has two nearly equal cusps and a posterior talon or tubercle.

The zygomas are widely arched laterally. The skull is short and usually arched, the orbits being large and the longitudinal crest less powerfully developed than in Canidæ. There is no ali-sphenoid canal. The bullæ are divided into two chambers. There are but thirteen dorsal vertebræ.

The *Felidæ* live almost exclusively upon flesh and prefer living prey, upon which most species creep with remarkable patience and skill, and rarely pursue an animal which they have failed to secure at the first spring. A remarkable habit which prevails among the cats is that of prolonging the excitement of the chase by trifling with the prey after it is partially disabled.

The *Felidæ* do not hunt in packs but singly, or, during the youth of the kittens, in pairs. The cats have a most interesting and pathetic affection for the young, which are cared for with unwearying devotion and protected with unreserved self-sacrifice. There are ordinarily two or three young, although domestic races become more prolific. The maternal instinct is so great that the young of other animals are often adopted when the mother is deprived of her kittens.

The living members of the family may be grouped in three genera, the principal one *Felis* containing the cats proper, the second, *Lynx*, the short-tailed northern cats, and the third, *Cynœlurus*, the cheetah, or hunting leopard.

The last named genus contains three species, or more probably, three varieties of a single species. These are *C. jubatus*, *C. guttatus* and *C. lanea*. The head is cat-like but the body is more like that of a dog, the legs being long and the claws not retractile. The pupil is round instead of linear, and various osteological peculiarities distinguish this genus quite fully from the cats proper. The several forms are found from India to southern Africa.

Genus FELIS.

Although numerically the largest genus of the *Felidæ* it is represented in the United States by a single species, the panther or cougar. There are between forty and forty-five species

of this genus, of which brief descriptions may be found in Mivart's "The Cat," and in general works on natural history. It will be sufficient to give the names of these and their habitat.

1 *Felis leo*, Lion–Africa, Arabia and formerly Europe and India.
2 *Felis tigris*, Tiger—Asia, Java.
3 *Felis pardis*, Leopard—Africa and Southern Asia.
4 *Felis uncia*, Ounce—Highlands of Central Asia.
5 FELIS CONCOLOR, Puma—America.
6 *Felis onca*, Jaguar—South America, N. to U. S.
7 *Felis macrocelis*, Clouded Tiger—South Eastern Asia.
8 *Felis scripta*, Thibet Tiger—Thibet.
9 *Felis tristis*, Fontaneir's Cat—China.
10 *Felis aurata*, Bay Cat—Nepal, Sumatra, Borneo.
11 *Felis viverrina*, Fishing Cat—Bengal.
12 *Felis bengalensis*, Leopard—Eastern Asia.
13 *Felis wagati*, Wagati—India.
14 *Felis marmorata*, Marbled Tiger—Nepal to Borneo.
15 *Felis serval*, Serval—Africa.
16 *Felis rutila*, Golden-haired Cat—Sierra Leone and Gambia.
17 *Felis neglecta*, Grey African Cat—Gambia.
18 *Felis servalina*, Servaline Cat—Sierra Leone.
19 *Felis pardalis*, Ocelot—South America.
20 *Felis tigrina*, Margay—South America.
21 *Felis guigna*, Guigna—South America.
22 *Felis pardinoides*, Ocelot-like Cat—South America.
23 *Felis yaguarondi*, Yaguarondi—South America.
24 *Felis eyra*, Eyra—South America.
25 *Felis colocollo*, Colocollo—South America.
26 *Felis rubiginosa*, Rusty-spotted Cat—Madras, Ceylon.
27 *Felis chinensis*, Chinese Cat—China.
28 *Felis minuta*, Little Cat—Phillippine Islands.
29 *Felis jerdoni*, Jerdon's Cat—(?)
30 *Felis planiceps*, Flat-headed Cat—Malacca, Borneo.
31 *Felis badia*, Bornean Bay Cat—Borneo.
32 *Felis caligata*, Egyptian Cat—Egypt.
33 *Felis catus*, Common Wild Cat—Europe.
34 *Felis torquata*, Indian Wild Cat—India.
35 *Felis chaus*, Jungle Cat—India.
36 *Felis ornata*, Ornamented Jungle Cat—India.
37 *Felis caudatus*, Steppe Cat—Bokara.
38 *Felis shawiana*, Shaw's Cat—Turkestan.
39 *Felis manul*, Manul—Siberia, Thibet.
40 *Felis pajeros*, Pampas Cat—South America

The most obvious external peculiarity of the genus Felis is the long and, frequently, tufted tail, the comparatively short legs, the lack of ear tufts and the (commonly) circular pupil. The dentition is $\frac{3}{3}$, $\frac{1}{1}$, $\frac{3}{2}$, $\frac{1}{1}$. The milk dentition is $\frac{3}{3}$, $\frac{1}{1}$, $\frac{3}{2}$, there being no distinction into molars and premolars.

Felis concolor L.

THE PUMA. See Plate II.)

Felis concolor LINNEUS. Mantissa, 1771, p. 522.
ERXLEBEN. Syst. Anim., 1777, p. 511.
SCHREBER. Saeugethiere, vol. III, 1778, p. 394.
BODDOERT. El. Anim., I. 1784, p. 90.
CUVIER. Recherches sur. esp. viv. d. grandchats, 1809.
GRIFFITH. Class Quadrim., order Carniv., 1821.
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DOUGHTY. Cabinet Nat. Hist., 1830, p. 190.
FULLER. Period of gestation, Proc. Comm. Zool. Soc., Lond.,II, 1832, p. 62.
MARTIN. Proc. Zool. Soc., Lond., I, 1833, p. 120.
WAGNER. Sup. Schreb. Saeugth., 184, p. 461.
DEKAY. N. Y. Zoology, 1842, p. 47.
AUDUBON AND BACHMAN. Quad. N. A. II, 1851.
BURMEISTER. Thiere Braziliens, I, 1854.
BAIRD. Mammals, 1857, p. 83.
GIEBEL. Saeugethiere, 1859, p. 876.
Felis discolor SCHREBER. Saeugeth., III, 1778.
Felis puma SHAW. Gen. Zool., I, 1830, p. 358.
TRAIL. Remarks on Genus Felis. Mem. Werner Nat. Hist. Soc., 1823.
BARTLETT. Breeding of larger Felidæ, etc., Proc. Zool. Soc. London, 1861, p. 140.
FITZINGER. Revision der zur natuerlich. Familie der Katzen gehoerig. Formen. Sitz. math.—nat. Cl. K. Akad, Wiss. Wien, 1868-1869.
PUTNAM. American Panther. Am. Nat., 1871, p. 692.
COUES. Specimen of a cougar, Am. Sportsman, Jan. 1874.
BATTY. Felis concolor, Am. Sportsman, Apr. 1874.
OBER. Florida panther, Forest and Stream, Dec. 1874.—Standard Natural History.

Few of our native animals have excited the imagination, not to say fears, of the early settler of America to the same extent as this largest truly North American cat. To this fact must be due the great variety of names by which it is com-

FELIS CONCOLOR. PUMA.

monly called. Following the universal fashion among the colonists of applying familiar names to natural objects en countered, this large wild cat was early denominated "the panther," although it bears no resemblance to the leopard, which is the true panther. More natural was it to suppose that the animals brought in at first were all females of the lion species. This presumption was given probability by the uniform tawny color and penciled tail of the puma. The name "American lion" has clung to the animal ever since and served to exaggerate the prowess of the rather cowardly beast. The native names cougar and puma are most appropriately employed. The jaguar is the only feline in America which exceeds the puma in size. The length of a full grown male of the latter exceeds five feet to the root of the tail, which is about three feet long. A female may measure slightly less. When in good condition the weight reaches 150 pounds.

The body is long and slender, the head small, slender with large ears which have rounded conchs. The legs are short and stout and the feet are large. The tail is cylindrical and tapering and at times is furnished with a terminal brush.

The fur is short and soft but rather dull. The color of the body and legs is a uniform fulvous or reddish tint; the under surface is reddish white; lighter and yellowish about the eyes. Black is found only upon the muzzle and the tips of the ears. The general color is described as like that of the Virginia deer. The young are beautifully and variously mottled and barred with dark brown. The tail is ringed and there is a dusky patch upon the neck.

The puma ranges over the whole of South America and in North America north to latitude 50°–60°. It is never really abundant and conforms in its habits and dwelling places to the exigencies of its habitat. In Florida it inhabits the depths of the impassable everglades, in mountainous regions it makes its lair in the rocky fastnesses of rugged peaks. In Texas it is sometimes found in open prairies.

The puma is nocturnal by necessity, rather than choice, and sees quite well in day light. It preys upon small or feeble cattle, or such as are mired or otherwise disabled. Fawns, raccoons, skunks, birds and all small animals are eaten.

When provisions are plentiful the animal is said to only drink the blood of its victims as has been demonstrated by autopsies. As many as fifty sheep may be destroyed in one night by a single puma. In case of scarcity, on the other hand, even carrion is not discarded.

The courage is not great and, unless impelled by hunger or despair, it never attacks dogs or horses—much less man. During severe winters the puma may be driven to eat the porcupine and there are well authenticated instances where the animal has fallen a victim to his temerity. The prey seems not to be carried to the den which is in contrast with the habit of other beasts. It is said to kill its prey instantly by drawing back the head with the paw until the neck is broken. The ordinary cry of the puma is a sort of "mew" on a larger scale and more prolonged than that of the domestic cat. The male growls when disturbed and, especially in the pairing season, gives vent to wild and unearthly cries which have wrought upon the superstitions of the frontiersman.

It is stated that the puma or "painter," utters wailing human cries in order to lure the belated traveler to destruction. All such stories can easily be understood if one will take the pains to conceive of the result if the caterwauling of a domestic cat were magnified four or five times in power and singularity.

The female makes an affectionate mother. The young are carried 96—97 days and are suckled until half grown.

The young are born in the spring in northern regions, but farther south considerably later. Audubon found half-grown pumas in Texas in February.

Pumas do not hunt in packs as do the various species of the dog family, but until the kittens are grown they sometimes hunt in pairs.

No opportunity has been afforded for gathering anatomical details and the reader is referred to Audubon for additional information as to the habits of this species.

The most recent occurrence of the puma in Minnesota was in 1875 when a single individual was killed in Sunrise, Chisago Co. The following extracts contain all notices of this animal which I have been able to gather from the earlier writings:

In "Carver's Travels" p. 413, is the following account of the puma which seems by the context to be credited to the "Chipeway River." "The TYGER. The tyger of America resembles those of Africa and Asia, but is considerably smaller. Nor does it appear to be so fierce and ravenous as they are. The color of it is a darkish sallow, and it is entirely free from spots." "It is very seldom met with in this part of the world."

Mr. Merriam[1] gives the following statement concerning the panther:

1 *The mammals of the Adirondack regions of Northeastern New York.* C. Hart Merriam, M. D. Also in the *Transactions of the Linnæan Society of New York, 1884*, under the same title.

"The distance that a panther can pass over in a single leap is almost incredible. On level a single spring of twenty feet is by no means uncommon, and on one occasion Mr. Sheppard measured a leap over snow of nearly forty feet. In this instance there were three preliminary springs, and the panther struck his deer on the fourth. The longest leap measured by Mr. Sheppard was one of sixty feet, but here the panther jumped from a ledge of rocks about twenty feet above the level upon which the deer was standing. He struck it with such force as to knock it nearly a rod farther off.

Under certain conditions of the deep snows the deer cut in so deeply that the poor animals can make but slow progress. At such times a panther, by spreading the toes of his great broad paws, simulates a man on snow-shoes and sinks but a short distance in the snow. He thus gains a vital advantage over his prey, and will now give chase to and capture one that he missed on his first spring. Under no other circumstances will a panther pursue a deer, for he is too well aware of the uselessness of an attempt to overtake so fleet an animal. Immediately upon killing one he drags it bodily into some dense thicket or windfall, where he will not be likely to be observed. He has thus been known to drag a full-grown deer considerably over a hundred feet before reaching a satisfactory covert.

Unlike the wolf, he makes the most of his prey and devours it all before killing another. One deer generally lasts a panther a week or ten days, and during that time he may usually be found within a mile of the carcass, hidden under some log or uprooted tree. Sometimes, but very rarely, does he partially bury it, after each meal, by scraping leaves and brush over it. When all but enough for one or two meals has been eaten, the panther, especially if a female with young, will often make another hunt, but, if unsuccessful, returns to the remains of the old carcass."

At the risk of repeating the substance of a previous part of this chapter we quote from Merriam's above mentioned work remarks upon

Some Common Fallacies Concerning Panthers.

1st. Concerning the alleged fierceness of the panther.

"Even many very respectable works upon Natural History contain the most detailed and heart-rending accounts of the loss of human life by the brutal attacks of these ferocious beasts. * * * The illustrious Audubon, in his great work

upon the Quadrupeds of North America, cautions the reader not to credit the legends of the vulgar in regard to the ferocity of this animal, and its propensity to attack man, and then goes on to picture midnight encounters and hair-breadth escapes almost as thrilling as the story above quoted. Oh, the inconsistency of man! It is now so well known that the panther is one of the most cowardly of beasts, never attacking man unless wounded and cornered, that it is unnecessary to do more than contradict the popular impression to the contrary.

2d. Concerning the method of capturing its prey.

It is commonly and widely believed, and boldly asserted in print, that the panther lurks in ambush for its prey; that it lies in wait beside the runways of the wary deer, hidden by some rock or thicket, or crouching upon an overhanging limb, and falls, like a thunderbolt from heaven, upon the back of its hapless and unsuspecting victim. Such romances, however gratifying to the narrator, and entertaining to the community, are without foundation in fact. * * *

3d. Concerning the screams of the panther.

Who has not heard of the piercing cries and startling screams of the panther? Who has listened, about the evening campfire, to the tales of hunters and woodsmen, but has felt his blood run cold, and his hat tighten on his head, as the earnest speaker, perhaps in a whisper, and uninterrupted save by the sputtering of the fire, told of the time when, alone in the solitudes of the deep forest, and at the dead of night, he was suddenly awakened by a piercing scream that burst upon his weary ears. It seemed like the shriek of a woman in distress, or the pitiful wail of a lost child. Half asleep, quite bewildered, he starts to his feet to render assistance, when the glaring eye balls of a fierce cougar met his horrified gaze and acquainted him with the nature of his unwelcome guest!

An attack of indigestion, the cry of a loon, or the screech of an owl, a piece phosphorescent wood and a very moderate im agination, are all that are necessary, in the way of material and connctions, to build up a thrilling tale of this description. Indeed, the writer once had a bit of personal experience in this line that is not yet forgotten.

In conversing with honest hunters upon this point, it has been my uniform experience to find that those who have had most to do with panthers are most skeptical in regard to their cries.

4th. Concerning the size of the panther.

In talking with border hunters of a certain type, and in perusing the literature, one is every now and then confronted with the most fabulous statements concerning the size of the beast now under consideration. Some would have us believe that panthers have been killed and measured with a "two foot rule" that were eleven, twelve, and even thirteen feet in length Formidable beasts indeed! No less an authority than James DeKay tells us, in apparent good faith, that one was killed on an island in Fourth Lake (of the Fulton chain) in Herkimer county, that, when recently killed, "had a total length of eleven feet three inches". To those who are inclined to credit such statements I have only to say, measure off eleven feet on your floor; place the largest panther you ever saw on this measured line, and then tell me on what part of the beast you would "annex" or "splice on" the three or more additional feet.

5th. Concerning the way a panther carries its prey.

We often see statements to the effect that a panther has killed a deer or a young bullock, slung it over his back and marched off (perhaps up an embankment, or even climbed a tree) with it. A panther drags a deer along the ground just as a dog drags a sheep, or a cat a big piece of meat, and, if he is a large one, he may be able to lift the deer so high that only the hinder parts drag.

Felis domestica Linn.

DOMESTIC CAT.

The common domestic cat stands, as regards size, at nearly the other end of the series of true cats inaugurated in America by the jaguar and puma. At the time America was discoverd all civilized nations had adopted this animal and it had become a part of man's family wherever homes were known. With most of us there is something lacking in the cheer of the chimney corner without the contented purr of a favorite cat, and tabby has come to be associated with the innocent pleasures of childhood and with home comforts in maturer life.

A very full account of all that is known about pussy and her family may be found in St. George Mivart's "The Cat," London, 1881. As in the case of most of our domestic animals, the proper combination of qualities for permanent domestica-

tion seems to have been obtained by the union of several different races or species. Our cat seems to be the result of a union of the common wild cat of Europe, *Felis catus*, and the Egyptian cat, *Felis maniculata*. The cat was certainly domesticated in Egypt at a very early date and was an object of veneration. In Herodotus' time the cats of a house constituted in some sort the *Penates* or household gods. Both cats and dogs were early introduced into Italy, both being indicated in frescoes of Pompeii. The variation in coloration and form is considerable, although far less than in some other domestic animals. What is called the tabby variety is thought to have resulted from the admixture of wild cat blood. In the case of the tortoiseshell cat, we have an instance of a difference in coloration between the sexes, males being all but universally grey. The blue cats, or Carthusian breed, are of a bluish grey color and have fine, long, soft pelage. The Angora cat, too, is especially remarkable for its fine, long hair as well as its large size. The tailless manx cat is an interesting variety with a tendency toward the reduction of the size of the fore legs. Malay cats also have short tails. The habits of the domestic cat are sufficiently well known and appreciated. In America there is, of course, some change in the diet, but, in general, the cat may be said to travel with her own commissariat as the army of European pests usually keep pace with the cat's emigrations. In our state the field mice form no considerable part of pussy's diet at times, but the staple is always *Mus domestica*. Many cats capture the gopher, *Spermophilus*, habitually, although it seems not to be relished as well as murine food. The cat at times becomes partially insectivorous and feeds upon crickets or grasshoppers, but it appears that these serve as a relish or condiment simply. No cases have fallen under my notice of cats capturing rabbits, except when the latter are still very young. Darwin has given us an interesting example of the coherence of nature in the dependence of the price of clover seed upon cats, via. field mice and bumble bees.

Genus LYNX.

See remarks under Felidæ.

Lynx rufus (Gm.) Raf.

WILD CAT.

Felis rufa Gmelin, Schreber, Desmarest, F. Cuvier.
Blainville. Guldenstein, Temminck.
Lessing. Geoffroy St. Hillaire, Fischer.
Gervais. Blyth.
Lynx floridiana Rafinesque. Am. Month. Mag., 1817.
Lyncus rufus Gray. P. Z. S., 1867.
DeKay. Nat. Hist. N. Y., 1842.
Felix montana Desmarest, Lessing, Harlan.
LeConte. P. A. N. S., Phila., 1856.
Felis maculata Vig. and Horsf. Zool. Journ., 1829.
Lessing. Comp. Buff., 1839, etc.
Lynx rufus Rafinesque. Am Month. Mag., 1817.
Aud. and Bach. Quad., N. A.
Marcy. Expl. Red R., 1852.
Newberry. Pacif. R. R., Rep. VI, 1857.
Baird. Mam., N. A.
Allen. Bull. M. C. Z., 1871.
Coues and Yarrow. Surv. 100th Mer., 1875.
Merriam. Mam. Adiron., 1874.

Out of over a dozen specimens of wild cat examined, none presented the characters attributed to *L. canadensis.* It would not therefore be competent for me to discuss the validity of the two species or their relations, but it may be confidently stated that if there are two species in Minnesota, our sportsmen are much at fault. I was repeatedly shown specimens of "Lynx" which uniformly proved to be *L. rufus*, but all hunters claim that two species exist, though distinctive characters apart from difference in size could never be found.

It is preferable, however, to proceed with the description of the one known variable species.

The earliest account of the wild cat from Minnesota, seems to be this from Carver's travels, p. 416. "The cat of the mountains. This creature is in shape like a cat, only much larger. The hair or fur resembles also the skin of that domestic animal; the color, however, differs, for the former is of a reddish or orange cast, but grows lighter near the belly. The whole skin is beautified with black spots of different figures, of which those on the back are long, and those on the lower parts round. On the ears are black stripes. The creature is nearly as fierce as a leopard, but will seldom attack man."

The adult female is about three feet long. The following measurements may be accepted as characteristic:

Length, 3 ft.; head and body, 2 ft. 6 in.; tail, 6 in.; fore foot to callosity, 3.75; hind foot, 6.75; nose to corner of eye, 1.50; nose to ear opening, 4.50; nose to occiput, 5.37; breadth of head, 4 25.

The base of the fur is tawny black, the middle buffy yellow, terminal portion white, or white followed by longer or shorter black band. Ear tips black, pencil well developed. Below the terminal white portion is long, concealing the others. Thighs externally spotted and lighter, obscurely barred within. The upper arm is slightly barred externally, while internally there are several wide black bars. In the middle of the back the whole base of fur is black, the tips only being white. The tail is tipped with white. The ruff is moderately long and is composed of rather stiff harsh hairs. The above description applies to the winter pelage. As early as February the whole skin takes on the rufous tint before nearly confined to the flanks. In spring specimens, the base of the fur was pale Vandyke brown. In the yearling the head is of nearly the same size as the adult. The color seems independent of sex.

During severe weather the wild cat is often forced to feed upon the porcupine, and it is of no infrequent occurrence that she pays for her timerity with her life. I have several times secured them with the head and throat filled with the spines, rendering the animals helpless. Such specimens were invariably very poor and emaciated.

Family CANIDÆ.

The dog family, although brought into closer relations with the cat group, through the hyenas, is remarkable for rigid adherence to one type of structure and general habitus. The group, although a closed one, shows the most intimate connection between most, if not all, of its species.

Six genera are recognized, of which the largest is *Canis* or that containing the dogs and wolves, the latter forming the subgenus *Lupus*, while the foxes constitute the genus *Vulpes* The domestic dog furnishes a familiar and sufficient illustration of the external characters of the family.

The body varies in form, but is neither adapted to aquatic nor arboreal life, and the rather long, straight legs show the method of progression to be running simply. The head is

rather long and has a pointed muzzle and pointed erect ears. The claws are not retractile but are worn off by contact with the earth. Few species are strictly fossorial though many dig rapidly upon occasion. The tail is of moderate length and is most frequently covered by bushy hairs and is less flexible than in most of the *Felidæ*. The color is usually rather uniform, and only in a few cases vivid, and although the fur is thick is rarely of any commercial value. The teeth are strong and less specialized than in the cats. The general formula is as follows:—milk teeth $\frac{3}{3}.\frac{1}{1}.\frac{4}{4}=32$; permanent teeth $\frac{3}{3}.\frac{1}{1}.\frac{4}{4}.\frac{2}{3}=42$. The incisors are small and three lobed above and two-lobed below. The canines are long and curved and somewhat flattened laterally. The fourth upper premolar is the sectorial tooth, being composed of two trenchant blades or cones; from the base of the anterior blade springs a tubercle. The lower sectorial is formed by the first molar.

In the genus *Cyon*, found in India, there is one molar less below on either side making the whole number 40. The genus *Otocyon*, represented by a small fox-like dog in South Africa, has 46 to 48 teeth by the addition of one molar below and one or two above on either side. In some instances there are but four claws upon the fore feet but usually the thumb, although elevated above the other digits, has a perfect claw while the hind feet are four-toed. Most species secure their prey through their superior speed and endurance but, as they hunt in packs, what speed is unable to accomplish is brought about by concerted pursuit. In like manner, although individually very cowardly, the wild dogs are formidable enemies of the largest wild beasts and are much dreaded by man himself. It is that social instinct so foreign to the cat family which makes the dog dependent upon other members of his race or, when domesticated, upon the will of his master to a larger extent than in most animals, which makes him so well adapted for the companionship of overbearing man. Although carnivorous, many species seem to prefer carrion and not a few will adapt themselves to a partly vegetable diet. The sense of smell is the most highly developed of the senses and is more acute in this family than in any other. The ear is also well developed but the eye, even in nocturnal species, is not particularly keen. The bark of the domestic dog seems to be a result of association with man, all wild dogs indulging their mood and venting their feelings in demoniacal howls.

The *Canidæ* possess anal glands affording an odor of more or less power. As has been said, the dogs are found over the entire surface of the globe where carnivorous mammals occur. Even in Australia which has no other endemic placental mammal, the Dingo or native dog represents this family, although it may be taken for granted that this species was simply introduced in an early period. As regards their origin we know that while no clearly marked representative of the Canidæ lived during the Eocene period, there were nevertheless animals which possessed similar characters, more or less masked by inter-relationships with the other carnivorous families.

In the Miocene true representatives of the group are found. It would appear that the various families of Carnivora have in the main remained in the geographical regions where they were first brought to special development. Thus hyenas are now, as then, restricted to the old world and the raccoons to the western hemisphere. The views of naturalists are as yet by no means identical as to the probable origin of Carnivora in general, most assuming a Marsupial or Marsupial-like if non-Marsupial progenitor.*

The origin of the domestic dog from one or more species of wild dogs cannot be denied. But it is not possible to place the

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*We add a list of the more important species of the genera of the Canidæ.

Genus Canis.
- *C. lupus.* Europe, Asia and North America.
- *C. latrans.* Prairies of Central N. America.
- *C. cancrivorus.* Guiana.
- *C. jubatus.* Brazil.
- *C. antarcticus.* Falkland Ids.
- *C. lupaster*, C. (lupus?) N. Africa.
- *C. familiaris.* Domestic dog.
- *C. hodopylax.* Japan.
- *C. aureus* (Jackal). Africa and S. Asia.
- *C. mesomelas.* S. Africa.
- *C. dingo.* Australia.

Genus Vulpes.
- *V. vulpes.* Europe, Asia, N. America and N. Africa.
- *V. corsac.* India, central Asia, Asia minor.
- *V. zerda.* N. Africa.
- *V. lagopus.* (Polar fox.)
- (?) *V. velox.* Central North America.
- *V. virginianus.* Southern United States.
- *V. azaræ.* South America.
- *V. magellanicus.* Extreme S. America.

Genus Nyctereutes.
- (?) *N. procyonoides.* China and Japan.
- *N. viverrinus.* Japan.

Genus Otocyon.
- *O. megalotis.* South Africa.

Genus Lycaon.
- *L. pictus.*

finger on any one species of wolf and say this is the stock from which the dog sprang. It has been observed that the domestic dog in countries where only partially domesticated resembles very closely its wild neighbors, while in more civilized lands where the dog has become the companion of man, it is more difficult to detect the resemblance to any wild race. The monuments of Egypt contain drawings of various species of domestic dogs and there is no doubt that in every period and in all countries man has brought this willing servant under his yoke. Careful investigations therefore seem to have proved that our various races of dogs have been derived from various species of wild dogs with round pupils which different peoples have independently domesticated and finally caused to interbreed. The influences of civilization have constantly increased the natural tendency to variation until different breeds of dogs differ from each other more than the most widely diverse species of the wild representatives of the genus Canis.

In Minnesota we have representatives of two genera, and but three species.

GENUS CANIS. LINN.

This genus contains the larger species with long limbs and round pupils; the post-orbital process of the frontal bone is very convex, curving strongly downward. The fox-like wolves of South America furnish the transition between the *genera Canis* and *Vulpes*.

Canis lupus L.

The evidence that our timber-wolf, so called, is identical with the wolf of Europe, has been very complete, even since the days of Richardson, and, although Prof. Baird cast the great weight of his opinion against such identity, the greater number of modern authors in Europe as well as America, now consider them the same. Dr. J. A. Allen in his list of the "*Mammalia of Massachusetts*" has summarized the evidence in a way quite satisfactory to the writer, and we shall enter into no discussion of the subject.

The following tabulation of the varieties found is extracted from the Zoology of the 100th Meridian Reports.

a. WHITE WOLVES—*Canis lupus, albus* SABINE, etc. White, pure or washed with yellowish, with or without black-tipped tail. Among the largest. Northerly or Alpine.

b. GRIZZLED WOLVES—*C. variabilis* MAXIM., etc. White, more or less extensively grizzled with gray. Large, and rather northerly.

c. GRAY AND BRINDLED WOLVES—*C. lupus* (Auct). Gray, of variable shade and pattern, generally brindled, darker dorsally, paler or white below, little or no rufous. Medium size. Most general distribution.

d. RED WOLVES—*C. lupus, var. rufus* AUD. AND BACH. Mixed, reddish and black, paler below, small. Southerly, especially Texas.

e. DUSKY WOLVES—*C. nubilus* SAY. Dusky or plumbeous brown, with or without darker muzzle bands and leg stripe. Small, chiefly southerly.

f. BLACK WOLVES—*C. lupus, ater* RICHARDSON. Black. Small, southerly, Florida.

The wolf drawn on Plate VI measured over four feet in length, tail, 19 in.; nose to eye, 5; nose to ear, nearly 9; nose to tip of ear, 12; eye to eye, 3¼. The lower canine was 1¼ long. Weight 85 lbs.

The following incidents were furnished me by Mr. Upham and illustrate certain traits of wolf character:

"Mr. John D. Wilcox, of Pine City, Superintendent of Schools for Pine county, told me that about the year 1860, when he lived at Sunrise in Chisago county, having worked through a winter day in the woods, making sugar-troughs, one and a half miles from home, which was at Sunrise, he was chased by a half dozen or more wolves, which he saw bounding up and down in their pursuit on his track, and heard their yelping; with the greatest haste possible he got across the open land where he then was and climbed up into a tree, but only barely in time to save himself, for the wolves were immediately at the tree, jumping up, yelping, and making the evening hideous. This continued two hours or more, the wolves all the time howling and leaping up, their eyes glowing like coals of fire. Finally they got into a fight among themselves and turned off into a neighboring swamp. This fight with much crashing of the alders, snarling and yelping of the wolves, and joy of Mr. W. to hear his foes waging war on each other, lasted an hour or so; then all became as still as death, he finally got down and escaped home. His axe, left at the foot of the tree, had its handle so gnawed and split that it was spoiled. Woodsmen have a saying that when a pack of wolves thus are foiled and lose their expected prey, they turn on the wolf that first led them into the pursuit and slay him.

The same winter (or rather, spring,) a Swede a few miles from Sunrise, making maple sugar at night and going out to gather sap, was attacked by wolves, and is said to have been wholly eaten up, not a bone being left, except his feet, which were gnawed as far down as the wolves could reach into his boots;—only shreds and small scraps of his clothing were found.

In the winter of 1877 or 1878, Mr. Wilcox had been to do some surveying on the upper part of Sand creek, east of Kettle river. Returning to Pine City through the woods with no roads, he heard a wolf cry behind him as early as nine o'clock in the forenoon; and, looking back, he saw him within a distance of twenty rods. On being shouted at this wolf turned back; but within a half hour others, hearing his howls, had joined him, and about the middle of the forenoon, looking back across a little swamp that he had crossed, Mr. W. saw three wolves coming along on his track, every now and then putting down their noses to the scent and uttering short yelps. This was at a distance of twenty-five miles or more from his home, and he would probably see no human being till reaching his own door, at the south end of Cross lake, a half mile southeast of Pine City. To be pursued and treed would be to starve to death. An expedient never before heard of by Mr. W., saved his life. Passing through a piece of birch woods, he stripped off a large amount of the bark and made a fire of it exactly in his path. Then he hurried on,—and soon, in about a quarter of an hour, when the wolves came up to this fire, they made all the woods ring with their howls of astonishment, rage, and disappointment. Their cries continued to be heard for an hour, or to the distance of fully two miles; but as he heard no more of them later, he supposes none of them ventured beyond this barrier of fire.

This danger from *wolves* is only in the last part of winter and spring; and their chasing lone travelers at other seasons has never been heard of.

During the winter of 1884–85, wolves became very abundant and insolent in Wright county, and were seen about the outskirts of Monticello in broad daylight almost daily, though they were sufficiently wary to escape capture.

Canis latrans Say.

COYOTE.

Canis latrans Say, Harlan, Audubon, Baird, Coues, etc.
Canis frustror Woodhouse.
Canis ochropus Eschsch, etc.

The occurrence of the prairie wolf in Minnesota must rest on other than personal information. I presume it is still not infrequent in the south-western counties.

Color dingy white, suffused above with tawny or grey. The light ground color is marked by obscure streaks of black, especially on the back and hips. The top of the muzzle, ears, and outsides of legs is tan color.

Entire length, 54 inches, of which the tail measures 18, nose to eye, 4; nose to ear, 8; nose to occiput, 8-9; hight at shoulder, 24. In general the size and proportions are those of a fair sized pointer dog.

The coyote is a familiar pest upon the plains of the central United States, and is a very persistent, if cowardly neighbor. Its food varies with the exigencies of its situation. While it prefers live game, and shows much endurance in its pursuit, it will not reject offal and the refuse from the campers meals. It will follow a party long distances subsisting on what is thrown away. When hard pressed, however, it has recourse to vegetable substances, such as the fruit of the prickly pear, juniper and other berries. The howl is remarkably melancholy, and does not tend to enliven the solitude of its domain It consists of a short quick bark, followed by others in quick succession in ascending gamut, until they are combined in one long drawn wail. The clamor is greatest at night-fall and continues through the night at intervals, breaking up with a noisy demonstration at daybreak.

Dr. Coues insists on the close similarity between the coyote and the ancestor of the domestic dog. The Indian dog interbreeds freely, it is asserted, with the wild animal and the crosses are perfectly fertile.

The female after a period gestation similar to that of the dog brings forth five or six puppies in secluded spots, caverns or recesses in the rocks. The only available means of destroying these wolves seems to be poison, as they avoid traps sedulously.

Genus VULPES.

The foxes differ from wolves and dogs in their elliptical pupil, bushy tail, more slender form, unlobed upper incisors and form of the postorbital process. South America furnishes a perfect transition in its wolf-like foxes with circular pupils. Aside from the Arctic fox which is circumpolar this genus contains *V. velox* and *V. macrus* of the plains (neither of which is known from Minnesota) and the red fox.

Vulpes vulgaris L.

This familiar animal is distributed over the whole north temperate region and is everywhere very variable. There is some little reason to suppose that the red fox has been introduced into this country, if not by man, at least later than the gray fox, the bones of which are found abundantly in bone caverns.

The red fox is about 40 inches long, the tail occupying 18 inches. Hight 12-14 inches. In the ordinary variety the

general color is tawny red, rather darker on the shoulders and flanks. The tail hairs are dark tipped; the outside of the legs and back of ears are also black. The under parts including the chin and a space about the muzzle and also the tip of the tail, are white.

The variations from this pattern are now generally considered to be due to melanism for which no satisfactory cause can be assigned. Complete melanism gives us the *Black or Silver-Gray Fox* (*V. argentatus*). In high latitudes often quite black save the tip of the tail. Elsewhere this phase consists in a silvery gray coloration of the upper parts.

Intermediate conditions give rise to the *Cross-Fox* (*V. decussatus*) in which the ventral line, muzzle and legs are blackish, with two cross bars on the inside of the legs. The median line above is also dark and is crossed by a dark shoulder band. The head is gray and the sides are marked with fulvous.

It is authoritatively stated that these so-called varieties may be found in the same litter, though to what extent the variations are inherited, is not known. Audubon gives an interesting case of this sort. The usual food of foxes seems to be field and wood mice and rabbits, and it is probable that their efforts in this direction deserve to palliate their occasional forays on the poultry yard. We are fortunately exempt in this country from the mania for fox hunting prevalent in Europe, though it might be well if some other, if less exciting inducement to equestrian exercise, could be secured. The fox hunts alone or in families, and is thus unlike the wolves. The young are five to seven in number and are tenderly nurtured, it being during the rearing of this growing family that the fox becomes most audacious and destructive. It would be idle to recount tales of the acumen of the fox, though one is tempted to revert to the folk lore of the south as illustrating a tendency to present another view of Reynard.

Anyone, who like the writer has watched unobserved the playful gambols of a family of young foxes, will have a weakness for the gay pests ever after.

Genus UROCYON.

This genus is distinguished from the foxes, of the genus Vulpes, by the fact that the crests for the insertion of the temporal muscles are widely separate, by the presence of a supplementary tubercle on the lower sectorial and a mane of rigid hairs on the tail.

Urocyon cinero-argentatus SCHREB.

Vulpes virginianus AUCT.

It is questionable whether the frequent accounts of gray foxes in Minnesota do not rest on mistaken identification. At any rate, this species is rather a southern animal, being the most abundant form in Virginia, westward to Arizona and California.

The size is that of the red fox, though the proportions are more robust. The prevailing color is a clear gray, darkest dorsally. The sides are more or less tawny or fulvous, muzzle with black band, under surface of head, white. The tip of the ail is blackish. The most remarkable character is that already referred to by which this genus has been called that of mane-tailed foxes.

The gray fox is a woodland animal and does not form extended burrows. It is said to climb with some degree of agility. It, therefore, is first to be driven out by the advance of civilization. Indeed it is more easily eradicated from its failure to take to the earth.

Family MUSTELIDÆ.

EXPLANATION OF FIG. 7.

No. 1. *Meles taxus*- European Badger.
No. 2. *Conepatus suffocans* -Brazilian sp.
No. 3. *Gulo luscus*—Glutton.
No. 4. *Mydaus telagon* of Java.
No. 5. *Lyncodon patagonicus*
No 6. *Galictis barbata*—South America.
No. 7. *Ratelus capensis*—African Honey Badger.

Carnivorous mammals of various form and habits chiefly interesting on account of the dense pelt which frequently becomes an article of great commercial value.

The following technical characters may be first given:

Skull with paroccipital processes distant from bulla; mastoid processes prominent, the various sutures usually closing very completely. Clavicles rudimentary or absent; scaphoid and lunar carpals coalescent; digits clawed. Limbs and tail free and perfect, the former adapted for terrestrial progression. Placenta zonary, deciduous. Intestine without a cæ-

cum. Cowper's glands absent. Dentition consisting of twelve incisors (except in the Sea Otter) of similar form, four canines which are not furnished with a sharp angle or ridges behind, a variable number of premolars, and one pair of molars above and two below (except in the Honey Badgers.) Anal glands secreting a strong odor always present.

As will be seen beyond, this family contains a number of quite unlike groups. Some of the *Mustelidæ* are highly aquatic, others dwell almost exclusively in trees, while many are strictly terrestrial. The economic importance of the family is derived from the large number of fur bearing animals it includes. The ermine, sable, marten, otter, mink, etc. all are members of the group. The northern hemisphere is the home of the family, although there are representatives in Africa and South America. We append Dr. Gill's synopsis of the sub-families and add a brief review of the group before taking up our native species.

Family MUSTELIDÆ.

I. Skull with the cerebral portion comparatively compressed backwards; and with the rostral portion comparatively produced, attenuated, and transversely convex above; anteorbital foramen small and opening forwards. Feet with little developed or no interdigital membrane.

A. Auditory bulla much inflated, undivided, bulging, and convex forwards; periotic region extending little outwards or backwards. Palate moderately emarginated.

1. Last molar of upper jaw transverse (with the inner ledge inflated at its inner angle); sectorial tooth with a single inner cusp.

a. Molars $\frac{1}{2}$; first true molar (sectorial) of lower jaw followed by a second (tubercular) one. Toes short regularly arched, and with the last phalanges bent up, withdrawing the claws into sheaths. [Weasels]—Mustelinæ.

b. Molars $\frac{1}{1}$; first true molar (sectorial) of lower jaw only developed. Toes straight, with the last phalanges and claws extended; the latter non-retractile. [Honey Badgers]—Mellivorinæ.

2. Molars $\frac{1}{2}$; last molar of upper jaw enlarged and more or less extended longitudinally. Toes straight with the last phalanges and claws extended; the latter non-retractile. [Badgers]—Melinæ.

B. Auditory bulla elongated and extending backward close to the paroccipital process. Palate moderately emarginated.

1. Last molar of upper jaw transverse; (with the inner ledge narrowed inwards); sectorial tooth with two inner cusps. [Helictis]—Helictidinæ.

C. Auditory bulla inflated, undivided, with the anterior inferior extremity pointed and commonly united to the prolonged hamular process of the pterygoid. Palate moderately emarginated.

1. Last molar of upper jaw transverse; with the inner ledge compressed. [Zorilla]—Zorillinæ.

D. Auditory bulla little inflated, transversely constricted behind the meatus auditorius externus and thence inwards; in front flattened forwards; periotic region expanded outwards and backwards. Palate deeply emarginated.

1. Last molar of upper jaw quadrangular, wide, but with an extended outer incisorial ledge. [Skunks]—MEPHITINÆ.

II. Skull with the cerebral portion swollen backwards and outwards, and with the rostral portion abbreviated, high and truncated forwards, and widened and depressed above; anteorbital foramen enlarged and produced downwards and backwards. Feet with well-developed interdigital membrane, and adapted for swimming.

A. Teeth normal, 36 (m $\frac{1}{2}$, p m $\frac{4}{3}$, c $\frac{1}{1}$, i $\frac{3}{3}$ × 2): sectorial tooth (p m $\frac{4}{1}$) normal efficient, with an expanded inner ledge; the other molars submustline. Posterior feet with normally long digits. [Otters]—LUTRINÆ.

B. Teeth very aberrant, 32 (m $\frac{1}{2}$, p m $\frac{3}{3}$, c $\frac{1}{1}$, i $\frac{3}{3}$—the lower inner incisors being lost—× 2); sectorial tooth (p m $\frac{4}{1}$) defunctionalized as such, compressed from before backwards; the other molars also with blunted cusps. Posterior feet with elongated digits. [Sea Otters]—ENHYDRINÆ.

Recognizing the taxonomic value of these sub-families as diagnosed by Dr. Gill, we may yet admit that for practical purposes the more artificial and older arrangement has many practical advantages. According to this, the sub-divisions of the family are three, founded upon the structure of the foot: a, plantigrade species—the badgers; b, digitigrade species—the weasels; c, oar-footed species—the otters.

Among the badgers we may mention, aside from our own familiar *Taxidea*, described beyond, the European badger, *Meles taxus*, which inhabits the whole temperate region of the Asiato-European continent as far as Japan. In form and habits it resembles its American relative while the East Indian badger has a longer tail and is different in color, forming the genus *Arctonyx*. *Mydaus telagon* is an animal which seems rather to connect the badgers with the skunks, both in appearance and in habits. It is smaller than the badger and has a white dorsal stripe. It also discharges a fœtid fluid from the anal glands when attacked. Africa possesses several representatives of the group which likewise are intermediate between the badgers and skunks. The honey badgers (*Mellivora*) have well developed anal glands and the peaceful disposition which characterizes the skunks, but in form resemble the badger. For a further discussion of the relations of the two groups, see the chapter on the Mephitidæ.

SUB-FAMILY MELINÆ.

THE BADGERS.

We have already given the diagnosis of the sub-family with sufficient detail for our present purpose and may pass to an account of the only species of the American genus Taxidea.

GENUS TAXIDEA, WATERHOUSE.

Dentition $\frac{3}{3}.\frac{1}{1}.\frac{3}{3}.\frac{1}{2}=34$. Skull expanded behind, the intermastoid diameter nearly equaling the inter-zygomatic. Auditory bullæ very much inflated, impinging behind upon the paroccipitals. Palatals extending half way to the ends of the pterygoids. Coronoid process of jaw erect, pointed. Anterior molar below rather small, posterior lower molar bi-tuberculate. Back upper molar forming a right-angled triangle, with the hypothenuse directed backward and outward. Limbs short, fossorial. Body depressed. Tail short, flat. Pelage long flaccid covering the back like a thatch.

Taxidea americana BAIRD.

PLATE III.

BADGER.

One specimen only of the badger has been seen during the survey and from its comparative rarity no additional information has been gathered. I am therefore forced to draw wholly from Coues' N. A. Mustelidæ, a work so generally accessible as to render synonomy and exhaustive descriptive matter unnecessary. The species is distributed throughout the United States west of Wisconsin, extending farther east in British America. In Mexico a sub-species *T. berlandieri* takes its place. "The badger varies greatly in color, as a fortuitous matter of age, season, or condition of pelage, aside from certain geographical differences. The variation, however, is mainly in the relative amounts of the blackish tawny-gray and white which produce the general grizzle, the pattern of coloration being well preserved, especially as to the markings of the head. The top of the head is dark brown or blackish, generally increasing in intensity and purity from the nape to the snout. This dark area is divided lengthwise by a sharp white or whitish median stripe, which runs from the snout, or just back of it, to the nape, where it is generally lost in the grizzle of that part. The

TAXIDEA AMERICANA. BADGER.

sides of the extreme muzzle are dark, like the top of the head; from about opposite the canines the sides of the head and ears are white, continuous with the white of the chin and throat, but interrupted by a large dusky patch in front of the ear. The whole body and tail above are an intimately blended mixture of blackish with white, hoary gray, and tawny. Owing to the length and coarseness of the pelage, the museum specimens present a patchy or streaky appearance. The feet are dark brown or blackish; the claws are generally light colored, especially those of the fore feet."

The badger is preeminently fossorial and extremely shy, being almost as difficult to observe above ground as the pouched gophers. The true home of the animal is the prairie region of the upper Missouri, where its holes are said to honeycomb the earth.

The badger is the determined enemy of the spermophiles and field mice and feeds on all animal matter afforded. It possesses itself almost perfect immunity from all enemies but man. In spite of its retiring habit the badger is no coward, as the old amusement of badger baiting testifies. Endurance and great strength are combined with marvelous vitality. The habits during the breeding season are unknown, there being three or four young at a birth. Badgers may be trapped by placing a fox trap at the mouth of the burrow, or by flooding in early spring.

The animal is, like its European relative, fond of honey which it is adept in securing. The European species breeds in October, when the sexes are associated in the same burrow, but at other times they live the life of hermits. The young, three to five in number, are born in March and are carefully cared for by the mother. In northern regions the animal hibernates, but further south adapts itself to the warmer climate.

Sub-Family MEPHITINÆ.

THE SKUNKS.

This is a comparatively small group confined to America, where it is represented by two genera, one of which only is North American while the other is nearly confined to the southern division of the new world. Although seemingly so well entitled to an exclusive position by the peculiarity through which they are notorious, the skunks are in many respects

nearly related with the badgers. This does not appear conspicuously upon a comparison of the only American species of that group with *Mephitis*, but is clear upon examination of certain intermediate genera of the old world. Such an example is afforded by the Telagon (*Mydaus telagon*) of Java, etc. This animal, although of a brown color, has the peculiar white marking upon the back characteristic of the skunks. The tail is, however, even shorter than in the badger's, and is white tipped. The resemblance to the skunks is farther enhanced by the fact that they discharge at pleasure a stream of the offensive fluid secreted by the anal glands. This fluid, to judge from the accounts of observers, must be about as subtile and powerfully pungent as that of the well known native animal. Curiously enough the next nearest relatives of the skunk are found in Africa and India, in the honey badgers (*Ratelus*). Two species are known, one of which is native to south and central Africa (*R. capensis*), the other occurs in East India. (The occurrence of members of the same genus in so far distant and isolated stations, may be incidentally noticed as confirmatory evidence of the previous more intimate connection of the two continents, and the consequent submergence of large land areas in what is now the Indian ocean.) In *Ratelus* the outward appearance (figure 7, No. 7) is badger-like even to the mantle like covering of long hair on the back. The tail is perhaps more bushy than in the badger, while the powerful odor constitutes a remarkable reminder of the skunks proper. The habits of the entire group, including all the above mentioned types, seem to be in close conformity, save in so far as the possession of the effective defensive weapon in certain of the genera renders the animals careless and even adventurous while the others are among the most reclusive of Carnivora. Of the anatomy of the exotic species above mentioned, little is known to substantiate the suggestions made upon the basis of external resemblances and physiological similarities. The dentition of 1, the Zorillinæ, also African, is said to be closely allied to Mephitis. *Mydaus*, however, accords with that of the true skunks, while the honey badgers have but 32 teeth, a reduction of one molar above.

Of the two genera of the Mephitinæ proper *Conepatus*, as represented by a single very variable species widely distributed in South America, (if indeed several species are not confounded under one name) bears the greatest resemblance to the badgers. Dr. Coues says (N. A. Mustelidæ p. 188): "The

skunks and badgers agree in many points of external conformation; in fact *Conepatus mapurito*, one of the skunks is almost as much of a badger, to all outward appearance."

As regards the one peculiarity of this sub-family without which a skunk would be no skunk, it may be interesting to quote again from Dr. Coues (l. c. p. 191): "In contemplating this singular provision of nature for the protection of an otherwise inoffensive and almost defenseless creature, we can but admire the simplicity of the means employed. Some little further development of glands common to the *Mustelidæ* and some inscrutable modification of the operations in the secretory follicles, which gives a peculiar character to the fluid elaborated, results in means of self-preservation as singular as it is efficacious, habitual reliance upon which changes the economy of the animal and impresses its whole nature." For a description of the glands see beyond.

The account given by Chatin in the *Annales des Sciences Naturelles*, 1874, furnishes us with the following facts regarding the anatomy of these parts in the South American genus *Conepatus*:

The glandular part, beginning 33 mm. from the prostrate gland, is nearly trapezoidal and lies beneath the urethra. It is enveloped in a thick muscular tunic constituted chiefly by fibres from the ischio-cavernous and bulbo-cavernous muscles and about 3 mm. thick. Within these muscular layers is the glandular portion proper occupying but a limited part of the surface of the reservoir. The cæca of the follicles, 0.55 mm in diameter, are of various shapes. The reservoir itself is very large and covered by a thick tunic of dense, white, laminated tissue and elastic fibres. Toward the anterior part of the cavity is the inner opening of the duct. The ducts open outwardly in two papillæ situated on either side the anus, about 9 mm. from the median line. These papillæ together with the anus itself, are hidden by flaps of skin covering the entire depression in which both are found.

The account of Dr. J. S. Parker of the anatomy of the anal glands of *Mephitis* being the only one which touches upon the physical characters of the secretion itself, we transcribe a portion of the article. American Naturalist, 1871, p. 246.

"I examined the cavity of the pelvic bones, without any peculiar result, and at last detached all except the hard, muscular pouches and the common fundamental aperture. These I carefully cut loose, and thus reduced the formidable animal to the last and least parts possible, and they seemed totally inadequate to explain the well-known effect which this animal produces. I next boldly severed, longitudinally, the rectum and anus; nothing was to be seen worthy of remark, except two teat-like projections in two volcanic or crater-like cavities that seemed suggestive of what might happen. So I cut away all the remaining superfluous parts

and at last had the anal lips, two muscular pouches and the small glands connected with them. My fortitude here giving out, and it growing dark, I adjourned the matter to the next day.

When I resumed operations, on the parts now weighing only about two ounces out of a Mephitis of nine pounds, I had a strip of skin with the anal lips, the suspicious calices or cones in their cup-like cavities and the pouches. * * * I began by severing the two muscular pouches and found no connection between them. Books say 'the animal gives its peculiar and penetrating odor from two glands situated external to pelvis.' I found the 'glands' to be clear muscular fibre, with not a particle of smell, or a trace of any glandular structure. Further to test the matter, I cut slowly to the middle of the mass of muscular, not glandular, fibres and came upon a thick, white leathery capsule like the crop of a chicken, with the source for the contents provided by the little glands about it. Now, putting on old clothes and sitting to the windward, I cut through this white capsule; a bright yellow fluid came out and I instantly felt that 'distance would lend enchantment to the view.' But I was not to be baffled. So I dipped the point of my scalpel in the yellow fluid, put the tenth or twentieth part of a drop on a glass and covered it with another strip of glass, and placed it under a power of forty diameters in my microscope. The appearance was peculiar. It looked like moulten gold, or like quicksilver of the finest golden color. Pressure on the strips of glass made it flow like globules of melted gold.

By a power of sixty diameters the same color still appeared, but seemed as if it would by a higher power resolve itself into globules, with peculiar markings. * * * To the eye, the peculiar and odoriferous secretion of this animal is of a pale bright glistening yellow, with specks floating in it. By the microscope it looks like a clear fluid, as water with masses of gold in it, and the specks like bubbles of air covered with gold, or rather air in golden sacs. The air I take to be the gas nascent from the golden fluid. * * * Another thing was a matter of interest. If I correctly made out the capsule of fluid, the commonly called 'glands' are the muscular tunic enveloping and capable of compressing the reservoir, and their sole use is to eject the liquid. The teat like projections have one large orifice for a distant jet of the substance, and also a strainer, with numerous holes—like the holes in the cones of the human kidney—for a near but diffusive jetting of the matter. The substance is secreted by small dark glands, of small callibre, connected with the capsule by narrow ducts."

The technical peculiarities characteristic of the skunks are here collated.

Skull. Dental formula: i. $\frac{3}{3}:\frac{3}{3}$, c. $\frac{1}{1}:\frac{1}{1}$, pm. $\frac{3}{3}:\frac{3}{3}$, $(\frac{3}{3}:\frac{3}{3})$, m. $\frac{1}{1}:\frac{1}{1}=\frac{19}{19}(\frac{18}{18})=34(32)$. The variation indicated in the premolar formula occurs in the genus *Conepatus*, where the number is usually (but, according to Coues, not always as once supposed) $\frac{2}{3}:\frac{2}{3}$. A comparison of the inferior aspect of the skull of *Mephitis* with that of *Putorius* shows that there is no anterior extension of the orbital space and consequent elongation of the zygomatic arch. The encroachment on the palatal part of the maxillary

thus brought about in the weasel causes the great reduction of the last molar and the apparent revolution of the axis through 90 degrees, so that it stands at right angles to the remainder of the series. It is this condition of the orbits and zygoma and the abbreviation of the facial region which finds its extreme in the weasels which produces, in part at least, the great extension of the palate in that group; and the converse condition in *Mephitis* produces the effect of a deep emargination of the palate extending frequently as far as the molars. In most of the other *Mustelidæ* the palatal bridge extends more than half way to the pterygoids.

The form of the teeth, as well as their position, differs from that of the types of the family. The upper incisors are chisel-shaped and bent backward near the end, while those of the lower jaw are straight and squarely truncate apically, opposing the surface thus formed to the oblique edge of the upper teeth. The lower premolars are small and conical, while the third upper one is the sectorial. It has, however, a very considerable development of the salient anterior lobe found even in *Putorius* but so highly developed in the badgers that the tooth is as much a grinder as a sectorial. The upper molar is quadrate, but wider than long. The lower jaw as a whole differs very little from that of the *Mustelinæ*. The foramina incisiva are narrow. The posterior nares are separated by a bony septum almost to the posterior edge of the palate. The pterygoids are hooked and of moderate size. The zygomatic arch is not compressed laterally, nor as strongly curved upward as in the *Mustelinæ*. The glenoid fossa is of considerable size and is well arched behind, yet looks more downward than in the weasels, although never locked. The auditory bulla lies close to the post-glenoid prominence, and the meatus opens just posterior to the zygomatic process of the temporal, in contrast to that of the *Mustelinæ*. The bullæ are very little inflated, in this respect differing greatly from the badgers. The mastoid processes are produced and directed forward.

Generic characters of Mephitis.

Teeth, 34; formulas: i. $\frac{3}{3}:\frac{3}{3}$, c, $\frac{1}{1}:\frac{1}{1}$, pm. $\frac{3}{3}:\frac{3}{3}$, m. $\frac{1}{2}:\frac{1}{2}$. Frontal region tumid, dorsal outline of skull irregular. Palate not extending beyond the molar series. Condyle of mandible projecting laterally, coronoid process with both margins convex, angle slightly flaring outward. Soles quite narrow. Tail very long and bushy. Color black with white dorsal markings.

It is now accepted that there are but two valid species of

Mephitis. The first is the widely distributed and variable *M. mephitica*, the second a smaller form made by Coues the type of a distinct subgenus (*Spilogale*) with the following additional characters: "Skull depressed, the dorsal outline approaching straightness, particularly over the orbits. Zygomata strongly arched upward, highest in the middle. Post-orbital processes well developed. Mastoid processes slight, scarcely produced beyond orifice of meatus. Periotic region peculiarly inflated by development of mastoid sinuses, the under surface swollen, and giving a *quasi* appearance of a second bulla auditoria behind the real one." The characters of subgenus *Mephitis* of Coues are the converse of these.

From the *Mustelinæ*, as represented by *Putorius*, *Mephitis* is sharply distinguished by the following additional osteological characters: The bones of the limbs are short, heavy and straight. The scapula is quadrangular, not triangular, and the metacromium less developed. There are but two vertebræ in the sacrum. The pelvis is broad triangular behind with produced ischiatic spines. The sternebræ are short. (These are probably family characters, but lack of material makes it safer to introduce them here.) For a few other points in the osteology see under *M. mephitica*.

Mephitis mephitica.

THE COMMON SKUNK.

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Descriptive and Biographical:

In this case, as well as generally where species of the *Mustelidæ* are concerned, our account can be little more than an abridgement of the excellent and exhaustive treatment found in Coues' Fur-bearing Animals, in which all the prior accounts are accompanied by the results of the author's studies of all the material collected by the various officers of the national scientific departments.

As Minnesota is credited with but one (quite sufficient) representative of the sub-family *Mephitinæ*, the reader is referred to the statements under that head for the more general facts relating to this animal.

This well known animal may be described as the incense-bearer of the sylvan deities, and yet the odor of sanctity which clings to the sable and ermine of its vestures suggests that those deities belong in the theogony of Pluto. The tonsure is represented by a band of white extending to the forehead, and the phylacteries are of snowy whiteness and are folded back to decorate the shoulders. The train is usually white and of plumy delicacy. In consonance with his priestly robes the demeanor is sedate and devoid of any impetuousness. Whatever unpleasantness may occur he never betrays alarm or incertitude, but pursues his way with the same quiet and unostentatious dignity. Seriously, but for the unpleasant nature of the secretion of the anal glands (which secretion, however, is char acteristic of mink, weasels and the *Mustelidæ* in general, as well as many rodents), the skunk would be an interesting and even a useful animal, forming a valuable auxiliary to the gardener if not to the poultryman. Relying upon his unsavory reputation, this animal is far less wary than most small mammals, and being but partially nocturnal, may often be seen, where abundant, in daytime ambling quietly along in search of insects, worms, small mammals, such as mice, etc., which form the staple articles of his diet. The appearance of man ordinarily causes him to scarcely accelerate his pace or turn from his

course. Every country boy has had his more or less memorable encounter with the animal in question. A sort of legendary terror adds imagined danger to such escapades, for in reality one has but to behave as composedly as the *Mephitis* certainly will, to escape discomfiture. If it be really necessary to remove such a neighbor, it is easy to take him in a trap set at the mouth of the burrow, though it then becomes a question how to dispose of the prize. A well directed charge of shot is perhaps the surest way to avoid unpleasant consequences. When taken in a trap, however, a skillful person can safely administer a quietus with a staff, by striking upon the head, especially if the foot is placed upon the tail. A properly constructed "deadfall" is a convenient way of at once trapping and killing the animal. If, for any reason, firearms are unavailable, the animal when trapped may be disposed of as suggested by C. L. Whitman in *The Forest and Stream*, 1876.

"My favorite method of dealing with them is as follows: With a tough annealed No. 15 or 16 iron wire I form a slip-noose about five inches in diameter and a standing loop of two inches on the other, and a space of five inches between. The loop is attached to the smaller end of a light, stiff pole of eight or ten feet in length. With this firmly grasped in both hands, I slowly and carefully approach, and slip the noose over his head, and with a quick jerk backwards and upwards, lift him as high as the chain of the trap will allow, and thus hold him until he is strangled. . . . If the jerk upward has not been adroitly made, the wire may not draw as tight as it ought; in which case a discharge of the pungent odor will usually follow, but in this perpendicular position the discharge descends directly downwards, so that if the attack has been made from the windward, as it ought, there is no danger. The approach is sometimes resented at first, but the gradual arching of the tail gives timely warning, and a careful retreat is necessary for a moment. The second or third attempt is successful. The animal by that time recovers from the alarm, and at most will merely sniff the air in your direction. With this device I have destroyed many hundred during the past thirty years, and do not recollect an instance where I bore any of the odor about me, except I had inadvertently trod upon dirt that was defiled."

We pass to description of the external appearance and coloration. The coloration is the point which first attracts attention, and is sufficiently characteristic that there need never be any hesitation in referring the animal to this genus. The

coarse, flaccid pelage is chiefly deep lustreless black relieved with areas of the most plumy white. Although Dr. Coues is inclined to doubt even the varietal value of the distinction made by previous authors, it seems certain that in given localities the pattern of coloration is quite constant. Strictly speaking, all the skunks which we have collected belong to the *Mephites mesomelas* of Lichenstein. In this variety, the coloration of which, as Dr. Coues admits, is normal in the west, there is a cuneiform or elongated and distinct white frontal spot and a broad conspicuous nuchal patch separated from the former by a very black band between the ears. A distinct black stripe, beginning back of the shoulders, separates the rather broad lateral bands of white which converge to a union anterior to the root of the tail, which is entirely white, dorsally and apically, with, however, a broad black band underneath. The same pattern is seen in two-thirds grown young of the year as in the parent female, but there is a preponderance of white in the former. The soles are not hairy in summer, but doubtless become so in winter. The elevating of that point to a chief specific character, as is done by Baird in the Mammals of N. A., seems amusing.

Comparing the coloration of our animal with that of other varieties, we find in the eastern United States the white areas are greatly restricted. However, great variations occur. The frontal stripe may nearly disappear, or may merge with the muchal area; the lateral lines may be distinct, or may extend part way upon the tail or unite anteriorly. The tail may be nearly or quite black, but more frequently marked with white, especially terminally. Even when apparently black the base of many of the hairs is white. The white elongated hairs of the tail are of a different texture from the remainder of the pelage. Indeed the tail entirely lacks the under fur found elsewhere. Toward the south the amount of white is reduced along with the size of the animal.

Next to the color the elongated and very bushy tail is the most conspicuous external character separating *Mephitis* from its allies. In some cases, as in that represented in plate 102 of Audubon, the long hairs spread in all directions when elevated, so that the member has been aptly likened to the plumes of a pompon.

The short legs and plantigrade walk give a peculiar mincing character to the gait. The nose is elongated, and forms the acute apex of the conical head. The eye is small and oblique.

The ear is low and nearly hidden in the fur. The back part of the animal is very large comparatively, as though for the support of the tail. The toes are very short, especially on the anterior extremities. The claws in front are rather large.

Although the skunk is so confident in nature's provision for its defense, its reliance is at times misplaced, for it sometimes falls a victim to its temerity. The fox, particularly, manages to destroy and make a meal of it. Owls and large hawks also sometimes feed upon them. The skunk hibernates partially in northern latitudes, but it is said wakens periodically to empty its reservoirs.

Dr. Merriam, whose extended experience with the animal in question makes him excellent authority upon it, gives the following interesting particulars concerning the skunk in domestication :*

"Skunks, particularly when young, make very pretty pets, being attractive in appearance, gentle in disposition, interesting in manners, and cleanly in habits—rare qualities indeed! They are playful, sometimes mischievous, and manifest considerable affection for those who have care of them. I have had, at different times, ten skunks in confinement. They were all quite young, measuring from 100 to 150 mm. (approximately 4 to 7 in.) only in length, when first taken. Some were dug out of their holes, and the rest caught in box traps. Two were so young that they could walk but a few steps at a time, and had to be brought up on milk, being fed with a spoon. The others ate meat and insects from the start. From some of them I removed the scent bags, but the greater number were left in a state of nature. None ever emitted any odor, although a couple of them, when half grown, used to assume a painfully suggestive attitude on the too near approach of strangers—so suggestive, indeed, that their visitors commonly beat a hasty retreat. These same skunks, when I came within reach, would climb up my legs and get into my arms. They liked to be caressed, and never offered to bite. Others that I have had did not show the aversion to strangers evinced by this pair, and I believe the difference to be due to the way in which they are brought up. If accustomed to the presence of a number of people they are familiar and friendly toward all; while if kept where they habitually see but one or two persons they will not permit a stranger to touch them.

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*Mammals of the Adirondack Region, p. 73.

Two summers ago I was the happy master of the cleverest young skunk that I have thus far chanced to meet. For a name he received the title of his genus, and we called him 'Meph.' for short. By way of precaution, I removed his scent sacs, and he made a rapid and complete recovery, after a few days of temporary indisposition. While driving about the country, in the performance of professional duties, he usually slept in my pocket. After supper I commonly took a walk, and he always followed close at my heels. If I chanced to walk too fast for him, he would scold and stamp with his fore-feet, and if I persisted in keeping too far ahead, would turn about disgusted, and make off in an opposite direction, but if I stopped and called him, he would hurry along at a sort of ambling pace, and soon overtake me. He was particularly fond of ladies, and I think it was the dress that attracted him; but be that as it may, he would invariably leave me to follow any lady that chanced to come near. We used to walk through the woods to a large meadow that abounded in grasshoppers. Here 'Meph.' would fairly revel in his favorite food, and it was rich sport to watch his manœuvres. When a grasshopper jumped he jumped, and I have seen him with as many as three in his mouth and two under his fore-paws at one time! He would eat so many that his over-extended belly actually dragged upon the ground, and, when so full that he could hold no more, would still catch and slay them. When so small that he could hardly toddle about he never hesitated to tackle the large and powerful beetle known as the horned bug, and got many smart nips for his audacity. But he was a courageous little fellow and it was not long before he learned to handle them with impunity. Ere many weeks he ventured to attack a mouse, and the ferocity displayed in its destruction was truly astonishing. He devoured the entire body of his victim, and growled and stamped his feet if any one came near before the repast was over."

P. 421 Carver's Travels:

"THE SKUNK. This is the most extraordinary animal that the American woods produce. It lives chiefly in the woods and hedges. But its extraordinary powers are only shewn when it is pursued. As soon as he finds himself in danger he ejects to a great distance a small stream of water of so subtile a nature, and at the same time of so powerful a smell, that the air is tainted with it for half a mile in circumference. On this

account he is called by the French, Enfant du Diable, the Child of the devil, or Bete Puante, the Stinking Beast. This water is supposed by naturalists to be its urine, but I have dissected many of them that I have shot, and have found within their bellies, near the urinal vessels, a small receptacle of water totally distinct from the bladder. After having taken out with great care the bag wherein this water is lodged, I have frequently fed on them, and have found them very sweet and good."

GENUS GULO, STORR. (*Wolverenes.*)*

(Fig. 6 [3].)

This genus contains but a single species of very wide range in both hemispheres. The largest North American representative of the weasel family (*Mustelidæ*). Form clumsy, somewhat bear-like, pelage shaggy, gait partly plantigrade. The tail is bushy and rather short. The claws are curved and large. The skull is particularly massive, and its spinous development is great. The dentition is as in the martens (*Mustela*) $\frac{3}{3}:\frac{1}{1}:\frac{4}{4}:\frac{1}{2}=38$. The anterior molar below is the sectorial but lacks the internal cusp. Mastoids and bullæ prominent.

There are seven cervical vertibræ, fifteen dorsal, five lumbar, three sacral, and about fifteen caudals.

There are well developed anal glands affording an offensive odor. Circumpolar. Name from Latin *gulo*, a glutton, in allusion to the voracity of the animal.

Gulo borealis NILSSON.

THE WOLVERENE.

Mustela gulo LINNÆUS, GUNN, HOUTTON, etc.
Ursus gulo SCHREBER, Sæugethiere, 1778; ZIMMERMANN, Geog. Gesch., 1780; GMELIN, SHAW, CUVIER, etc.
Meles gulo PALLAS, Spic. Zool., 1780.
Taxus gulo TIEDEMANN, Zool., 1808.
Gulo borealis NILSSON, Illum. Fig. till Skan. Fn.; RETZ., CUVIER, WAGNER, KEYSOR and BLASIUS, SCHINZ, BLASIUS, BRANDT, GRAY, VOGT, etc.
Gulo sibiricus PALLAS.
Gulo arcticus DESMAREST, LESSON, FISCHER, GIEBEL, FITZINGER, etc.
Gulo vulgaris GRIFFITH, SMITH, etc.
Ursus luscus LINNÆUS, Systema Naturæ; ERXLEBEN, SCHREBER, ZIMMERMANN, GMELIN, SHAW, TURTON.

* Our account is chiefly a compilation from the exhaustive article of Dr. Coues in the Monograph of North American Mustelidæ.

Gulo luscus SABINE, Franklin's Journal, 1823; RICHARDSON, FISCHER, GODMAN, ROSS, SMITH, DEKAY, GRAY, AUD. and BACH., THOMPSON, BAIRD, BILLINGS, MAXIMILLIAN, GERRARD, COUES, DALL, ALLEN, MERRIMAN; most recent American authors.

Gulo wolverine GRIFFITH. Animal Kingdom, 1827.

The wolverene is a stout heavy animal about two feet and one-half long, exclusive of the bushy tail, which measures about one foot. The form resembles both that of a bear cub and of a hyena. To the former the resemblance is borne out by the nearly plantigrade walk, while the sloping back and shagginess might suggest the latter, as do its habits. The palms and soles are densely covered with fur, except the small pads. The color is dark brownish black, darkest on the back. The sides are lighter, the color being greyish or yellowish. At the top of the head and in front of the ears is a grey or whitish area, and there are also light spots on the throat as in the martens.

Dr. Coues has favored us with a full historical account of the animal, from which the following quotations are made: "The written history of the Glutton or Wolverene, dates from an early period in the sixteenth century, when the animal is mentioned by several writers in much the same extravagant terms. The first appearance of the animal in literature is said by Von Martens to have been in 1532, at the hands of Mechow, a physician of Cracow, in the work *De Sarmatia Asiana et Europœa.* * * * Endorsed for two centuries by various writers, each more or less authoritative in his own times, and, moreover, appealing strongly to the love of the marvellous, the current fables took strong root and grew apace, flourishing like all 'ill weeds,' and choking sober accounts——the general picture impressed upon the susceptible mind of that period being that of a ravenous monster of insatiate voracity, matchless strength and supernatural cunning, a terror to all other beasts, the blood-thirsty master of the forest. — — — We read how the Glutton, too clumsy and tardy of foot to overtake large ruminants, betakes itself to the trees beneath which they may pass, and there crouches in wait for its victim; it drops like a bolt upon the unsuspecting elk, moose, reindeer, and fastening with claws and teeth, sucks the blood, and destroys them as they run. That nothing may be left undone to ensure success, the animal has the wit to throw down moss or lichens to attract its prey, and to employ the friendly services of foxes to drive the

quarry beneath the fatal spot. — — — We may remember also that the history of the Wolverene is mixed, in some cases, with that of other animals, some of whose habits have been attributed to it. Thus Charlevoix speaks of the '*Carcajou* or *Quincajou*, a kind of cat,' evidently, however, having the Cougar (*Felis concolor*) in view, as appears from the rest of his remarks." The name "*Carcajou*" appears in Carver's Travels (p. 420), and as the animal purports to be found in Minnesota, it may be interesting to quote the paragraph in full:

"THE CARCAJOU.—This creature, which is of the cat kind, is a terrible enemy to the preceding four species of beasts. He either comes upon them from some concealment unperceived, or climbs up into a tree, and taking his station in some of the branches, waits till one of them, driven by an extreme of heat or cold, takes shelter under it, when he fastens upon his neck, and opening the jugular vein, soon brings his prey to the ground. This he is enabled to do by his long tail, with which he encircles the body of his adversary; and the only means they have to shun their fate, is by flying immediately to the water. By this method, as the Carcajou has a great dislike to that element, he is sometimes got rid of before he can effect his purpose."

In this case the reference can only be to the puma, though partly fabulous. The single species of *Gulo* is circumpolar, and abounds to far north. Its southern limit is about 40° in suitable locations, although only a few instances are known of its occurrence so far south. In Minnesota I have no information of the animal, although it must have once existed here. In Europe this animal once ranged (as proven by quarternary remains) as far south as the Alps and Pyrenees, but is now restricted to the polar regions. In Asia the range is considerably greater. The wolverene is not strictly nocturnal, but, where abundant, may be encountered at any time of day or night, and in all seasons. He preys on small animals, and will even attack young caribou and deer. But the taste is not discriminating, everything being eaten which chance may throw in the way; even carrion is not rejected in case of need. The great stories told of his voracity constitute the bulk of the history of the animal, but he seems to be particularly characterized by marvelous cunning and endurance. The marten trapper often finds a skillful and inveterate energy in this large member of the marten family. A line of traps is visited as assiduously by the glutton as by the owner, and with disastrous results, for

the traps are destroyed and hidden, and the bait devoured or cached. According to northern explorers the animal is a victim of a senseless kleptomania, not contenting itself in confiscating everything it can devour, but stealing and secreting all articles it is able to carry. It may be itself trapped in a dead-fall or steel-trap of large size, but great skill is required to outwit the animal.

The wolverene brings forth four or five young, in secluded caverns or hollow logs, in June or July, and the female is said to be very fierce and even dangerous while guarding the young. The sense of smell is the best developed of the senses, the vision being particularly unreliable; which may give rise to the habit with which it is credited, of shading its eyes with its paw when looking at a distance.

Genus MUSTELA, Linn.

This genus, including the martens, differs in many respects from the glutton, and connects that animal with the slender weasels. The dental formulæ are identical, $\frac{3}{3}:\frac{1}{1}:\frac{4}{4}:\frac{1}{2}=38$, and differ from that of *Putoris* in having one more premolar above and below. The skull is much less massive and more tapering than in *Gulo*. The rostral portion is elongated. The frontal profile is concave. There are seven cervical vertebræ, sixteen dorsals, six lumbar, three sacral, and eighteen to twenty caudal. The form is stout and somewhat cat-like or fox-like; size moderate—that of a cat; progression digitigrade; fur dense and valuable; habit arboreal and terrestrial. Although many varieties are known to furriers, zoologically but four, or at most five, species can be recognized. The true sable is *M. zibellina*, closely allied to which is *M. martes*, the common European species. The house marten, *M. foina*, is of a greyer color, and has a longer tail than the above. Our own *M. americana*, or marten, closely resembles the *M. martes*, while the fisher is widely different. The following table of differentia may prove useful.

M. pennanti (Fischer). Length 2 feet or more, tail over 1 foot, tapering; ears wide, semi-circular; color blackish, darkest below; no light throat-patch.

M. americana. Length under 2 feet; tail less than 1 foot, uniformly bushy; ears high, triangular; color brownish, darker above, usually with a lighter patch on the throat.

Mustela pennanti ERXL.

PEKAN OR FISHER.

Mustela canadensis SCHREBER, etc.
Martes canadensis GRAY.
Viverra canadensis SHAW.
Viverra piscator SHAW.
Mustela melanorhyncha BODDAERT, etc.
Mustela nigra TURT.
Mustela godmani FISCHER.

The general aspect of the fisher is much like that of the fox, hence it is often popularly called "black fox." A full grown animal measures about 46 inches, the tail being 16 inches long. It is thus much larger than our other *Mustelidæ*, and is relatively much stouter and more compactly framed. The head is six inches long, the eye being two inches from the end of the muzzle. The ear is twice as broad as long, and is one inch high. The feet are broad and flat, furred on both sides, and armed with curved, compressed claws. The hind foot is 4–5 inches long. The tail is bushy and conical, and the fur is coarser than in the martens. The color is exceedingly variable, consisting of black and dark brown below, and greyish brown or reddish above. The belly, legs and tail are often black, though the breast is sometimes white spotted.

The name fisher is quite inappropriate, as the animal is not aquatic, but is said to have a feline repugnance to that element. Neither does it feed on fish, but pursues squirrels and other small quadrupeds.

Richardson says: "The Pekan is a larger and stronger animal than any variety of the Pine Marten, but has similar manners, climbing trees with facility, and preying principally upon mice. It lives in the woods, preferring damp places in the vicinity of water, in which respects it differs from the Marten, which is generally found in the dryest spots of pine forests. The fisher is said to prey on frogs in the summer season, but I have been informed that its favorite food is the Canada porcupine, which it kills by biting on the belly. It brings forth once a year, from two to four young."

The pekan is distributed from ocean to ocean, in wooded regions north of 35°, but its southern limit has been greatly altered by the inroads of the trapper. It is still reasonably abundant in the northern parts of our state.

This animal is stated to attack and destroy so large and powerful a creature as the raccoon. Sir John Richardson

states that "its favorite food is the Canada porcupine, which it kills by biting in the belly." Other writers have questioned the truth of this statement, but it has recently received additional verification. Mr. Merriam writes: "During a recent visit to the north shore of the Gulf of St. Lawrence, I was informed, both by an agent of the Hudson Bay Company and by the trappers themselves, that porcupines constitute a large and important element in the food supply of the Pekan. Mr. Nap. A. Corneau, of Godbout, who secured for me a large and handsome male of this species, tells me that its intestine contained hundreds of porcupine quills, arranged in clusters, like so many packages of needles, throughout its length. In no case had a single quill penetrated the mucous lining of the intestine, but they were apparently passing along its interior as smoothly and surely as if within a tube of glass or metal. Mr. Corneau did not discover a quill in any of the abdominal viscera, or anywhere in the abdominal cavity, excepting as above stated; a great many, however, were found imbedded in the muscles of the head, chest, back and legs, and it was remarkable that their presence gave rise to no irritation, no products of inflammation being found in their vicinity. In examining the partially cleaned skeleton of this specimen, I find some of the quills in the deep muscles and ligaments about the joints. A knee, in particular, shows several in its immediate neighbor hood."

The nest is made in a hollow tree, generally thirty or forty feet from the ground, and two to four young are brought forth about the first of May.

"They are agile and muscular animals, jumping from tree to tree like a squirrel, clearing a distance of forty feet in a descending leap, never failing of a secure grip."—Corporal Lot Warfield, quoted by Merriam.

Mustela americana TURTON.

AMERICAN SABLE OR MARTEN.

Mustela martes FORSTER, SABINE, HARLAN, EMMONS, AUD. and BACHMAN, BILLINGS, KENNICOTT, etc.
Mustela americana TURTON, BAIRD, COUES, etc.
Martes americana GRAY.
Mustela zibellina var. *americana* BRANDT.
Mustela vulpina RAFINESQUE.
Mustela leucopus KUHL.
Mustela huro F. CUVIER.

The body of the Marten is equal to that of a small cat, the entire length being about 30 inches, the tail measuring 12. The legs are short and strong. The tail is bushy and full toward the end, in contrast to the pekan. The head is broadly triangular and cat-like, the eyes being oblique and situated half way from snout to ears, which latter are high and rather pointed. The soles are furred, and the pelage throughout is dense, soft, and full. The color is brown of various shades, ranging from almost orange to nearly black, the latter being most valuable. On the throat there is a patch of yellowish or tawny, while the whole under surface is lighter than the upper. The fur is full from the end of October to the beginning of May. Toward the end of summer, after the moult, a fine short fur appears resembling that of a mink ; it gradually lengthens as winter approaches, and is considered prime after the first snow fall.

The American animal agrees with the European *M. martes* so closely in external appearance as to make it impossible to discover distinctive features, but the osteological features are said to be well marked. It is probably otherwise with *M. zebellina*, the true sable, which cannot at present be distinguished. The four species are certainly very closely allied, and show the martens to be of recent origin.

In the Bul of the U. S. Geological and Geographical Survey, vol. II, No. 4, Mr. J. A. Allen summarizes a large number of facts illustrating the geographical variation in this species, yet concludes that the three species, *foina*, *americana* and *martes*, are sufficiently distinct.

The rocky, woody district on the north shore of lake Superior and the national boundary is noted for its valuable black martens. The northern limit coincides with that of the forests.

"Sable are ordinarily captured in wooden traps of very simple construction, made on the spot. The traps are a little enclosure of stakes and brush in which the bait is placed upon a trigger, with a short upright stick supporting a log of wood ; the animal is shut off from the bait in any but the desired direction, and the log falls upon the victim with the slightest disturbance. A line of such traps, several to the mile, often extends many miles. The bait is any kind of meat, a mouse, squirrel, piece of fish, or bird's head. One of the greatest obstacles that the sable hunter has to contend with, in many localities, is the persistent destruction of his traps by the wolverine and pekan, both of which display great cunning

and perseverance in following up his line to eat the bait, and even the sables themselves may be captured. I have accounts from Hudson's Bay trappers of a sable road fifty miles long, containing 150 traps, every one of which was destroyed throughout the whole line twice—once by a wolf, and once by a wolverine. The marten is exceedingly shy, and never ventures into human enclosures; nevertheless, when captured, it makes a rather amiable pet and has little of the offensive odor of the family."

GENUS PUTORIUS.

Dental formula: i, $\frac{3}{3}$; c, $\frac{1}{1}$; pm. $\frac{3}{3}$; m, $\frac{1}{2}\times2=34$. Sectorial of lower jaw without an internal cusp. Skull flat, rostral portion short and turgid. Zygomatic arch usually not higher behind than in front. Periotic region, bullæ, etc., little inflated.

The body is usually very slender and lithe, the head short and fierce, with orbicular ears. The legs are short and stout, the tail uniformly terete. The genus is divided into four sections: *Gale* (ermines and weasles), *Cynomyonax* (American ferret), *Putorius* (ferrets), and *Lutreola* (minks). The American ferret is confined to the central plateau. The ferrets proper are stout-bodied forms confined to the Old World, thus leaving two of the groups to be considered.

The weasels proper are grouped under *Gale*, and have the following characters: The skull is smooth, with no sagittal crest. Frontal profile strongly convex and declivous. Pterygoids with small hamular processes, or none. Bullæ auditoriæ nicked at end by orifice of meatus. Skull moderately abruptly constricted near the middle; post orbital processes slight. Small animals of slender, serpentine form, of terrestrial habit. Most northern species become white in winter. We have in Minnesota two species.

Putorius vulgaris ALDROV.

LESSER WEASEL.

(FIG. 8 *B*.—COMMON ERMINE WEASEL.)

Mustela vulgaris, Earlier authors generally.
Fœtorius vulgaris KEYSOR and BLASIUS.
Mustela gale PALLAS.
Mustela nivalis FORSTER.
Mustela pusilla DEKAY.
Putorius pusillus AUDUBON.
Putorius cicognani RICHARDSON.

This species is circumpolar and is equally distributed in the New and Old World. In general it does not approach the poles as nearly as the ermine, but extends rather farther south. This species seems to have been domesticated as a mouser in Greece prior to the introduction of cats.

This species differs from the ermine in its smaller size. The length varies, eight inches being the maximum length of body, the tail about two and a half. The tail is almost always without the black terminal portion so characteristic of the larger species. The northern specimens turn white in winter, but in southern Minnesota probably not. But a single specimen was collected during the survey, and the notes upon this are incomplete.

Fig. 8. A. *Putorius erminea* (Ermine or White Weasel).
B. *Putorius vulgaris* (common Weasel).

Although only relatively rare it is far from well known. Its food is mice, insects, eggs and young birds. It is said to climb readily in search of nests. When a mouse is introduced into the cage containing a weasel, says Bell: "It instantly issued from its box, and in a moment, one single bite on the head pierced the brain, and laid the mouse dead without a struggle

or a cry. I have observed that when a weazel seizes a small animal, at the instant when the fatal bite is inflicted, it throws its long, lithe body over its prey, so as to secure it, should the first bite fail. The power which the weasel has of bending the head at right angles with the long and flexible neck gives it a great advantage." In pursuing a rat or mouse, it depends upon the sense of smell, and follows them with equal ease when out of sight, readily recovering the lost track. It is said that it even takes to the water in pursuit of its prey. Although the weasel may itself fall a victim to birds of prey, instances are known when the unequal contest has been carried on in the air, and the sharp tooth of the weasel has brought to the ground its winged captor. Four or five young are produced, there being two litters annually. A hollow tree or hole in a bank, well lined with leaves, forms the nest. The mother defends her young to the last extremity.

Putorius erminea LINN.

ERMINE, OR WHITE WEASEL

(PLATE XV, FIGS. 1-15. See ante.)

Mustela erminea, Earlier authors.
Putorius noviboracensis DEKAY, etc. (var. *cicognani.*)
Mustela cicognani BONAPARTE.
Putorius cicognani BAIRD, etc.
Putorius richardsoni RICHARDSON, BAIRD.
Mustela fusca AUD.
Putorius agilis AUD.
Putorius kanei BAIRD.

We accept unhesitatingly the identification of our species with that of Europe, and incline to regard the *P. longicaudata* as in the same category. This whole question has been so thoroughly discussed by Coues and Allen that it need not be reopened.

Every one is familiar with the cylindrical serpentine form, the flattened head notably shorter than the neck. As Coues says, "the eyes are rather small, situated midway between the nose and ears; they glitter with changing hues, and contribute with the low forhead and protruding canine teeth, to a peculiarly sinister and ferocious physiognomy. In northern regions the whole sole is furred, but elsewhere the pads appear."

In summer the upper parts are a uniform brown, varying from very dark umber to a yellowish gray, the line of demark

ation from the white of the lower parts is quite sharp. Only the end of the tail is black. The white of the under parts is suffused with a sulphury tint. The winter pelage is white, unbroken except by the black tip of the tail and the yellow suffusion. The change is a gradual one, and consists of a gradual substitution of white for the darker color, usually by gradual encroachment from below, leaving a constantly narrower dorsal band. Sometimes, however, the substitution goes on over the entire dorsal region simultaneously. Dr. Coues considers that the change is effected in either of two ways: Either the renewal of the pelage by the outgrowth of hairs of a different color, or the change of the hairs after their formation, cold being the conditioning circumstance in either case. We may be permitted to doubt that the question is satisfactorily settled. Two important purposes are subserved by the change, the animal is screened from observation and thus protected from its foes and rendered more successful in the chase, and the white color makes the pelage a less perfect conductor of the animal heat.

The Latin name *Putorius*, refers to the odor which is derived from the secretion of the anal glands, and is only less persistent and offensive than in the skunk.

The always pleasing pen of Mr. Wm. MacGillivray has furnished us with the following general account of the habits of the Stoat as observed in Great Britain:—"It appears that in England generally the Ermine is less common than the Weasel; but in Scotland, even to the south of the Frith of Forth, it is certainly of more frequent occurrence than that species; and for one Weasel I have seen at least five or six Ermines. It frequents stony places and thickets, among which it finds a secure retreat, as its agility enables it to outstrip even a dog in a short race, and the slimness of its body allows it to enter a very small aperture. Patches of furze, in particular, afford it perfect security, and it sometimes takes possession of a rabbit's burrow. It preys on game and other birds, from the grouse and ptarmigan downwards, sometimes attacks poultry or sucks their eggs, and is a determined enemy to rats and moles. Young rabbits and hares frequently become victims to its rapacity, and even full-grown individuals are sometimes destroyed by it. Although in general it does not appear to hunt by scent, yet it has been seen to trace its prey like a dog, following its track with certainty. Its motions are elegant, and its appearance extremely animated. It moves by leaping

or bounding, and is capable of running with great speed, although it seldom trusts itself beyond the immediate vicinity of cover. Under the excitement of pursuit, however, its courage is surprising, for it will attack, seize by the throat and cling to a grouse, hare or other animal, strong enough to carry it off; and it does not hesitate on ocasion to betake itself to the water. Sometimes, when met with in a thicket or stony place, it will stand and gaze upon the intruder, as if conscious of security; and, although its boldness has been exaggerated in the popular stories which have made their way into books of natural history, it cannot be denied that, in proportion to its size, it is at least as courageous as the tiger or the lion."

With a mind preoccupied in contemplation of the exploits of the chase of great *Carnivora*—those grand exhibitions of predatory instincts on the part of some of the strongest beasts, one is apt to overlook, or at least to underestimate, the comparative prowess of some lesser animals. Doubtless, the entomologist would give instances of equal courage and perseverance in pursuit of prey, of vastly greater comparative strength and skill in its capture, and superior destructiveness. Probably the great mass of insect-eating animals—an immense and varied host—are in no whit behind in this respect. And in nothing the instincts and predacious habits of the Weasels and Stoats, we observe that, to grant them only equal courage and equal comparative prowess, we must nevertheless accede to them a wider and more searching range of active operations against a greater variety of objects, more persevering and more enduring powers of chase, and a higher grade of pure destructiveness, taking more life than is necessary for immediate wants. The great cats are mainly restricted each to particular sources of food supply, which they secure by particular modes of attack; and, their hunger satisfied, they quietly await another call of nature. Not so, however, with the Weasels. No animal or bird, below a certain maximum of strength, or other means of self-defence, is safe from their ruthless and relentless pursuit. The enemy assails them not only upon the ground, but under it, and on trees, and in the water. Swift and sure-footed, he makes open chase and runs down his prey; keen of scent, he tracks them, and makes the fatal spring upon them unawares; lithe and of extraordinary slenderness of body, he follows the smaller through the intricacies of their hidden abodes, and kills them in their homes. And if he does not kill for the simple love of taking life, in gratification of

superlative bloodthirstiness, he at any rate kills instinctively more than he can possibly require for his support. I know not where to find a parallel among the larger *Carnivora*. Yet once more, which one of the larger animals will defend itself or its young at such enormous odds? A glance at the physiognomy of the Weasels would suffice to betray their character. The teeth are almost of the highest known raptorial character; the jaws are worked by enormous masses of muscles covering all the side of the skull. The forehead is low, and the nose is sharp; the eyes are small, penetrating, cunning; and glitter with an angry green light. There is something peculiar, moreover, in the way that this fierce face surmounts a body extraordinarily wiry, lithe, and muscular. It ends a remarkably long and slender neck in such way that it may be held at right angle with the axis of the latter. When the creature is glancing around, with the neck stretched up, and flat triangular head bent forward, swaying from one side to the other, we catch the likeness in a moment—it is the image of a serpent.

In further illustration of the character of the Stoat, I continue with an extract from Audubon, which represents nearly all that has appeared to the point in this country:—

"Graceful in form, rapid in his movements, and of untiring industry, he is withal a brave and fearless little fellow; conscious of security within the windings of his retreat among the logs, or heap of stones, he permits us to approach him within a few feet, then suddenly withdraws his head; we remain still for a moment, and he once more returns to his post of observation, watching curiously our every motion; seeming willing to claim association so long as we abstain from becoming his persecutor.

"Yet with all these external attractions, this little Weasel is fierce and bloodthirsty, possessing an intuitive propensity to destroy every animal and bird within its reach, some of which, such as the American rabbit, the ruffed grouse and domestic fowl, are ten times its own size. It is a notorious and hated depredator of the poultry house, and we have known forty well-grown fowls to have been killed in one night by a single Ermine. Satiated with the blood of probably a single fowl, the rest, like the flock slaughtered by the wolf in the sheepfold, were destroyed in obedience to a law of nature, an instinctive propensity to kill. We have traced the footsteps of this bloodsucking little animal on the snow, pursuing the trail of the American rabbit, and although it could

not overtake its prey by superior speed, yet the timid hare soon took refuge in the hollow of a tree, or in a hole dug by the Marmot, or Skunk. Thither it was pursued by the Ermine and destroyed, the skin and other remains at the mouth of the burrow bearing evidence of the fact. We observed an Ermine, after having captured a hare of the above species, first behead it and then drag the body some twenty yards over the fresh fallen snow, beneath which it was concealed, and the snow lightly pressed down over it; the little prowler displaying thereby a habit of which we became aware for the first time on that occasion. To avoid a dog that was in close pursuit, it mounted a tree and laid itself flat on a limb about twenty feet from the ground, from which it was finally shot. We have ascertained by successful experiments, repeated more than a hundred times, that the Ermine can be employed, in the manner of the Ferret of Europe, in driving our American rabbit from the burrow into which it has retreated. In one instance the Ermine employed had been captured only a few days before, and its canine teeth were filed in order to prevent its destroying the rabbit; a cord was placed around its neck to secure its return. It pursued the hare through all the windings of its burrow, and forced it to the mouth, where it could be taken in a net, or by the hand. In winter, after a snow storm, the ruffed grouse has a habit of plunging into the loose snow, where it remains at times for one or two days. In this passive state the Ermine sometimes detects and destroys it.

"Notwithstanding all these mischieveous and destructive habits, it is doubtful whether the Ermine is not rather a benefactor than an enemy to the farmer, ridding his granaries and fields of many depredators on the products of his labour, that would devour ten times the value of the poultry and eggs which, at long and uncertain intervals, it occasionally destroys. A mission appears to have been assigned it by Providence to lessen the rapidly multiplying number of mice of various species and the smaller rodentia.

"The White-footed Mouse is destructive to the grains in the wheat fields and in the stacks, as well as the nurseries of fruit-trees. Le Conte's Pine Mouse is injurious to the Irish and sweet potato crops, causing more to rot by nibbling holes in them than it consumes, and Wilson's Meadow-mouse lessens our annual product of hay by feeding on the grasses, and by its long and tortuous galleries among their roots.

"Whenever an Ermine has taken up its residence, the mice in its vicinity for half a mile around have been found rapidly to diminish in number. Their active little enemy is able to force its thin vermiform body into the burrows, it follows them to the end of their galleries, and destroys whole families. We have on several occasions, after a light snow, followed the trail of this Weasel through fields and meadows, and witnessed the immense destruction which it occasioned in a single night. It enters every hole under stumps, logs, stone heaps and fences, and evidences of its bloody deeds are seen in the mutilated remains of the mice scattered on the snow. The little Chipping or Ground Squirrel, *Tamias Lysteri* [*sc. striatus*] takes up its residence in the vicinity of the grain fields and is know to carry off in its cheek pouches vast quantities of wheat and buckwheat, to serve as winter stores The Ermine instinctively discovers these snug retreats, and in the space of a few minutes destroys a whole family of these beautiful little *Tamiæ;* without even resting awhile until it has consumed its now abundant food, its appetite craving for more blood, as if impelled by an irresistible destiny, it proceeds in search of other objects on which it may glut its insatiable vampire-like thirst. The Norway rat and the Common House Mouse take possession of our barns, wheat stacks, and granaries, and destroy vast quantities of grain. In some instances the farmer is reluctantly compelled to pay even more than a tithe in contributions towards the support of these pests. Let however an Ermine find its way into these barns and granaries, and there take up its winter residence, and the havoc which is made among the rats and mice will soon be observable. The Ermine pursues them to their farthest retreats, and in a few weeks the premises are entirely free from their depredations. We once placed a half domesticated Ermine in an outhouse infested with rats, shutting up the holes on the outside to prevent their escape. The little animal soon commenced his work of destruction. The squeaking of the rats was heard throughout the day. In the evening, it came out licking its mouth, and seemed like a hound after a long chase, much fatigued. A board of the floor was raised to enable us to ascertain the result of our experiment, and an immense number of rats were observed, which, although they had been killed in different parts of the building, had been dragged together, form ing a compact heap.

"The Ermine is then of immense benefit to the farmer. We are of the opinion that it has been over-hated and too indis

criminately persecuted. If detected in the poultry house, there is some excuse for destroying it, as, like the dog that has once been caught in the sheepfold, it may return to commit further depredations; but when it has taken up its residence under stone heaps and fences, in his fields, or his barn, the farmer would consult his interest by suffering it to remain, as by thus inviting it to a home, it will probably destroy more formidable enemies, relieve him from many petty annoyances, and save him many a bushel of grain."

The same author, alluding to the Weasel's want of shyness, and its ready capture in any kind of trap, continues with a matter that may next interest us—its relative abundance in different localities:—"This species does not appear to be very abundant anywhere. We have seldom found more than two or three on any farm in the Northern or Eastern States. We have ascertained that the immense number of tracks often seen in the snow in particular localities were made by a single animal, as by capturing one, no signs of other individuals were afterwards seen. We have observed it most abundant in stony regions; in Dutchess and Ontario counties in New York, on the hills of Connecticut and Vermont, and at the foot of the Alleghanies in Pennsylvania and Virginia. It is solitary in its habits, as we have seldom seen a pair together except in the rutting season. A family of young, however, are apt to remain in the same locality until autumn. In winter they separate, and we are inclined to think they do not hunt in couples or in packs like the wolf, but that, like the bat and the mink, each individual pursues its prey without copartnership, and hunts for its own benefit." In Massachusetts, according to Allen, it is comparatively common. I myself saw none in Labrador during my summer visit; but it must be quite abundant, to judge from the number of skins I saw in possession of the natives at various places. According to Richardson, "Ermine-skins formed part of the Canada exports in the time of Charlevoix; but they have so sunk in value, that they are said not to repay the Hudson's Bay Company the expense of collecting them, and very few are brought to the country from that quarter." Nevertheless, it would appear that the Ermine is much more abundant in British America generally than it is in the United States. Over three-fourths of the large miscellaneous collection of skins we have examined in the preparation of this article came from this country and from Alaska. The writer last mentioned speaks of it as "common", and adds that it often domesticates itself in the

houses of the fur traders, where it may be heard the live-long night pursuing the white-footed mouse. Up to a certain limit of latitude it would appear to increase in numbers to the northward. The abundance of an Ermine, either the present or succeeding species, on the Missouri is attested by the regalia of ceremony of some of the Indian tribes—picturesque constumes decorated with the tails, in rude imitation of royal fashion.

Like a majority of thoroughly predacious animals, the Ermine is somewhat nocturnal; that is to say, it is active and successful in the dark. Nevertheless, it is too often abroad in the daytime, either in sport or on the chase, to warrant our reckoning it among the truly nocturnal Carnivores. In the choice and construction of its retreats we see little evidence of burrowing instincts, or, indeed, of any considerable fossorial capacity. It retreats beneath stone heaps, under logs and stumps, in hollows of trees, and also in true underground burrows, though these, it should be observed, are usually those made by Rodents or other burrowers whom it has driven off or destroyed. Nevertheless, there is evidence that the animal sometimes digs. Thus Captain Lyon, as rendered by Richardson, states, that he observed a curious kind of burrow made by Ermines in the snow, "which was pushed up in the same manner as the tracks of moles through the earth in England. These passages run in a serpentine direction, and near the hole or dweling place the circles are multiplied, as if to render the approach more intricate." Audubon has a passage of similar effect:—"We have frequently observed where it had made long gallleries in the deep snow for twenty or thirty yards, and thus in going from one burrow to another, instead of travelling over the surface, it had constructed for itself a kind of tunnel beneath."

Accounts of different writers indicate a great variation in the number of young produced at a birth—from two to twelve. We may safely assume that these unusual extremes, the average litter being five or six. As in case of the Mink, the rutting season is early; in the United States, during a part of February and March. Young have been noted, toward the southern extreme of the range of the species, before the end of March; but most are produced in May or late in April. Without definite information respecting the period of gestation, we may surmise this to be about six or seven weeks. Information is also wanting of the length of time that the young nurse or require to have food brought them by the parents.

Of the mental characteristics of the ermine much has been written. In spite of its innocent appearance the little animal is probably the most bloodthirsty and blindly ferocious of our Carnivora. The following account, kindly furnished me by Dr. T. S. Roberts, illustrates the blind fury with which it resents interference:

"Going to a place on a small island in Lake of the Isles where had been left on the 12th inst., the skinned bodies of six muskrats, it was found that they had all disappeared. While standing near the spot the white head of a weasel appeared at a hole under the roots of a small oak tree close by. It soon withdrew again, and a steel trap was set at the entrance to the burrow. Presently it appeared at a second opening near by. Here a second trap was set. The weasel would come to the entrance, look out and go back again, passing and repassing with great agility over the trap without springing it. On walking away some distance and looking back the weasel was seen out of his retreat, and making violent efforts to drag the muskrat into his hole. On approaching again he tore away at the body furiously, but was forced to leave it. He seemed of a very irritable disposition, as he would tear and bite in the most insane manner at sticks and roots in the entrance of the hole, as if in a great rage. Once he appeared at the entrance and seizing one of the jaws of the trap tried to drag the whole down with him. At last, in a more than usually precipitate retreat over the trap he sprung it, and was a prisoner. He was as fierce as any large animal, and showed great fight."

Dr. Merriam says: "I once put a very large rat into a square tin cage with a weasel of this species. The rat had been caught in a steel trap by the toes of one of its hind feet, and was in no way injured. He was very ugly, biting fiercely at the trap and the stick with which I assisted him into the cage of the weasel. No sooner had he entered the cage than his whole manner and bearing changed. He immediately assumed an attitude of abject terror, and trembled from head to foot, and crawled into the nearest corner. The weasel advanced toward him at once, and as he did so the rat raised on his hind legs, letting his fore paws hang helplessly over his breast, and squealed piteously. not only did he show no disposition to fight, but offered no resistance whatever, and did not even attempt to defend himself when molested. The weasel did not seize him at first, but cuffed him with his fore paws. and drove him from one corner of the cage to another, glaring at him continuously. Then,

with a sudden move, he sprang upon his victim, already paralyzed with fear, laid open the back of the head with a single bite, ate the brains, and left the quivering carcass untouched."

In connection with the above vivid picture of the effect produced upon its victims by the appearance of the weasel, we may quote from Coues a passage showing how his aspect affects a more dispassionate and unbiassed observer:

"A glance at the physiognomy of the weasels would suffice to betray their character. The teeth are almost of the highest raptorial character; the jaws are worked by enormous masses of muscles covering all the sides of the skull. The forehead is low, and the nose is sharp; the eyes are small, penetrating, cunning, and glitter with an angry green light. There is something peculiar, moreover, in the way that this fierce head surmounts a body extraordinarily wiry, lithe and muscular. It ends in a remarkably long and slender neck, in such a way that it may be held at a right angle with the axis of the latter. When the creature is glancing around, with the neck stretched up, and the flat triangular head bent forward, swaying from one side to the other, we catch the likeness in a moment—it is the image of a serpent."

(?) **Putorius longicaudata** BONAPART.

LONG-TAILED WEASEL.

This species is noticed by Dr. Coues from Minnesota, though we have never seen it. The only external differences between this and the Ermine are the greater length of the tail ($\frac{3}{4}$ – $\frac{4}{5}$ as long as head and body) the terminal black portion of which is reduced, and the substitution of a salmon for a sulphur yellow on the under parts. The habitat is said to be the Upper Mis souri region. It would seem that a geographical variety or race is as high a distinction as the form deserves. In addition to the above external differences, it is true, the skull is said to be much wider—half as long as wide, the anteorbital foramen smaller, the upper posterior premolars inclined forward.

The species occupies the burrows of the Richardson's spermophile.

Putorius vison BRISSON.

MINK.

(PLATE XVIII.)

Mustela vison, Earlier writers.
Lutra vison SHAW.
Putorius vison, Modern writers.
Mustela lutreola FORSTER, SABINE, etc.
Vison lutreola GRAY.
Mustela canadensis ERXLEBEN, etc.
Mustela winingus BARTON.
Mustela minx TURTON.
Mustela lutreocephala HARLAN.

In size and external appearance the mink approaches the martens. The tail is bushy rather than cylindrical, but the head is triangular and flat like the weasels. The ear is very small. The fur is composed of a soft, dense under fur intermingled with long stiff shining hairs. The color is brown of various shades, from dark chocolate to yellowish. A broad dorsal area is darkest. The chin is white, and there may be other blotches of white on the under parts which are otherwise little lighter than the upper surface. As indicating the aquatic habit, the toes are webbed at the bases. The mink is distributed over N. America everywhere in suitable locations. Our species differs from the European *P. lutreola* in a few insignificant osteological points only.

Coincidentally with the aquatic habitat, the food of the Mink is somewhat modified, in comparison with that of the land species of the genus. It is probably our only species which feeds habitually upon reptiles, fish, molluscs, and crustaceans—more particularly upon frogs, fresh-water bivalves, crawfish, and the like. Nevertheless, it is not confined to such diet, but shows its relationships with the terrestrial Weasels in a wide range of the same articles of diet as the latter secure. It is said to prey upon Muskrats—a statement I have no hesitation in believing, though I cannot personally attest it. A recent writer,* in an article which I would quote were it written in a style suited to the present connection, narrates an incident which may be here briefly related, as showing that the Mink is a formidable enemy of the Muskrat, though yielding to the latter in weight. Whilst snipe-hunting on a marshy island below the Kickapoo Rapids of the Illinois River, the

*M. A. Howell, jr. "The trapper not the only enemy of the Muskrat."—*Forest and Stream* of *Dec. 21, 1876.*

writer noticed an object, which appeared like a ball some six or eight inches in diameter, rolling toward the water; and soon ascertained that it was a Mink and a Muskrat clinched together, and so completely covered with mud as not to have been at first recognized. At his approach, the Mink released its hold and make its escape; but the Muskrat was already dying of severe wounds in the head and neck, from which the blood was flowing profusely. The Muskrat had evidently been captured and overcome in fair fight by broad daylight, and the Mink would have devoured its victim had not the hunter interfered. It is also destructive to our native rats and mice—the *Arvicolas*, *Hesperomys*, *Sigmodon*, and *Neotoma;* it is known to capture Rabbits, especially the *Lepus palustris*, its associate in many marshy or swampy tracts; while its not infrequent visits to the poultry-yard have gained for it the hearty ill-will of the farmer. Various marsh-inhabiting birds are enumerated in the list of its prey, among them the rails and several smaller species; and we may presume that it does not spare their eggs. But most birds are removed from its attack; for the Mink is not a climber, at least to any extent. In respect to poultry, its destructiveness seems to result rather from the regularly repeated visits of an animal that has located in the vicinity than the wholesale slaughtering sometimes accomplished by the Ermine. According to those who have excellent opportunity of judging, the Mink does not as a rule kill more than it eats. Still, the opposite case has been recorded. Its modes of hunting offer nothing peculiar. Like the Weasel and Stoat, it has been known to pursue its prey by scent.

The Mink often annoys hunters by stealing the game they have shot before they have an opportunity of bagging it. An incident related by a recent anonymous writer in "Forest and Stream" is in point, and furthermore illustrates the wonderful energy and perseverance sometimes displayed by the Mink in securing its food. Speaking of a duck-shooting excursion, during which some of the birds that had been killed were not recovered till next day, the writer goes on to say:—"The first spot which claimed attention, was where our 'hen mallard' had 'struck hard pan.' Here was a sight! feathers and blood marked the scene of a terrific struggle for what remained of a duck's life. Here, for at least ten feet in circuit, the snow, grass and twigs, were whipped into a confused mass, here and there besprinkled with blood, and quite as often decorated with feathers; then there was a trail, leading directly to the

river bank, and out upon the ice; the trail thence proceeded up the bank of the river on the ice for about half a mile, when it disappeared directly in line of a hole in the bank, where we discovered the bird half buried, head foremost, into a hole about one-half the size of the body, frozen stiff. When discovered we worked, not without difficulty, at the extrication of the bird. It required all our force to draw it out, when, as it broke from its fastenings, two large Minks suddenly appeared, and darted back into their retreat, the last we saw of the varmints after a half hour of close watching. The ground along the shore was rough, covered with heavy grass, brush, drift wood, and many willows. Here the natural obstacles precluded the possibility of such a trip by land, and the little piece of engineering practiced by this one Mink, in capturing and conveying home its prize, was truly marvellous. That there was but one Mink, the trail bore direct evidence throughout its entire length from the scene of the struggle. As we followed the line, we could easily trace the wide trail of the mallard, as it was dragged bodily along over the fresh snow, and the deep penetration of its claws into the new ice, spoke volumes of the force exerted by that small animal in the completion of so severe an undertaking, and the excessive amount of *Mink power* expended in the completion of a successful foraging expedition. Here and there thoughout the line of trail were frequent halting places, where our Mink had stopped for *a rest*. Every time there appeared numerous tracks around the body of its victim, as though pleased to inspect its trophy before the next heat, and then as the distance shortened, the strokes of its tail at regular intervals of march, marked upon the snow upon either side of the trail the determined intention of the animal to go through with its *meat* before it was too cold to squeeze into a small space, where the sharp frost would soon fix it permanently. When drawn out, we found that a couple of 'square meals' had been made from the head, neck and breast, and enough left for several days to come."

This account of the Mink's theft called forth shortly afterward in the same paper the following instance of its stealing fish; the editor, Mr. Charles Hallock, remarking that he had known Minks to carry off fish weighing no less than twelve pounds:—"We were spending our vacation in the woods of Maine, fishing, and traveling about for a good time in general. One day we came across an old dam made to flood a piece of lowland. As this looked like a good place to fish we stopped, seated our-

selves upon the edge of the dam, and cast in our line. The fish were quite plenty, and as fast as we caught one we threw it behind us upon the scaffolding. After a dozen or so had been caught, I thought I would light my pipe, pick up the fish and put them in the shade, and I started to do so. I accomplished the first object, but upon looking for the fish I could not find a single one. I thought that my chum must have removed them, and was playing a joke upon me, but on mentioning it to him he was as much surprised as I was. They could not have fallen through the cracks, or leaped over the side without our knowing it. Where were they? That was the question. He returned to fish, and I seated myself upon the bank to digest the subject. Presently he caught another fish and threw it upon the boards. Immediately I saw a Mink run out from a hole near by, snatch the fish and carry it off. This explained the mysterious disappearance of the others."

The movements of the Mink on land, though sufficiently active, lack something of the extraordinary agility displayed by the more lithe and slender-bodied Weasels, as a consequence of the build of its body; while, for the same reason, it does not pursue the smaller animals into their extensive underground retreats, nor so habitually prowl about stone heaps and similar recesses. It is altogether a more openly aggressive marauder, though not less persistent and courageous in its attacks. It appears to be more perfectly at home in the water, where it swims with exactly the motions of an Otter, and in fact appears like a small specimen of that kind. It swims with most of the body submerged—perhaps only the end of the nose exposed—and progresses under water with perfect ease, remaining long without coming to the surface to breathe. This may be partly the reason of its long survival under the pressure of a deadfall.

The Mink is not properly a migratory animal. In most sections it remains permanently where it takes up its abode. In others, however, it may be forced to remove at times, owing to scarcity or failure of its food-supply, such as may ensue from the freezing of the waters in northern parts. Under such circumstances, it may perform extensive journeys overland. Trappers have indeed spoken to me of a "running" time with the Minks, but I cannot satisfy myself that reference is here had to anything more than periods of sexual activity, when the animals are hunting mates. I do not think that whatever "migration" may take place is anything more than casual.

The rutting season begins early—generally February—and April is for the most part the month of reproduction. Five or six young are ordinarily produced at a birth. Litters have been found in the hollow of a log, as well as in the customary burrows.

The Mink has been frequently tamed, and is said to become, with due care, perfectly gentle and tractable, though liable to sudden fits of anger, when no one is safe from its teeth. Without showing special affection, it seems fond of being caressed, and may ordinarily be handled with perfect impunity. The following account of the semi-domestication of Minks on an extensive scale will be read with interest, not alone for its novelty, but also because it gives some precise information respecting the reproduction of the species.

"*Minkeries.*"

The Mink appears to be the only species of its genus which has been systematically reared and trained for ratting in this country as the Ferret is in Europe. The relationship of the two animals at once suggests the feasibility of an experiment which has been tried with complete success, as we learn from an interesting article lately published in "Forest and Stream" (October 22, 1874—apparently taken from "Fancier's Journal and Poultry Exchange" of October 15, 1874). I reproduce the passage in substance.

Mr. H. Resseque, of Verona, Oneida County, N. Y., has frequently exhibited at fairs two tame female Minks, which he hands to the by-standers to be caressed and passed from one to another. The animals were perfectly gentle, submitting to be handled, but it was noticed that they kept their eyes on their keeper, to whom they would frequently extend their paws like a child wishing to be taken to its parent. Seven years ago, Mr. Resseque came in possession of a live wild Mink, and through her progeny his stock has on some occasions amounted to ninety individuals, besides the numerous specimens disposed of. At the late Albany County fair, his "minkery" was one of the novel features.

Mr. Resseque's minkery consists of twelve stalls, each twelve feet square, of stale soil, and surrounded with a fence and some special precautions to prevent the escape of the animals. In each stall is placed a dry-goods' box for the home of the female; it has two openings for ingress and egress, opposite each other, besides a door on top to allow of inspection and cleaning. The

animals are fed on sound, fresh meat, as they do not relish tainted flesh. In summer it is given to them daily, but in cold weather a large quantity is thrown in at once and allowed to freeze, the Minks helping themselves at pleasure. In February, their allowance is shortened, to get them into condition for breeding. Mr. Resseque claims that this slight degree of fasting makes them more lively and playful, and it is a part of his plan to imitate nature as closely as possible—their supply of food, in the wild state, being restricted at this season.

In the minkery, the sexes are not allowed to run together except during the month of March, which is considered the running season in a state of nature. If allowed together for a longer period, the male teases and annoys the female. At this time, the males fight desperately, and if not soon separated one always gets the mastery. The females come in heat with great regularity, all being ready for the male within ten days; and the period of excitement lasts about four days. One male serves six females. The females reproduce when one year old. The duration of gestation scarcely varies twelve hours from six weeks. There is but one litter annually. The litters run from three to ten in number; the young are born blind, and remain so for five weeks. When newly born, they are light-colored, hairless, and about the size and shape of a little finger. By the time the eyes are open, they are covered with a beautiful coat of glossy hair. The young females develop sooner than the males, attaining their stature in ten months, while the males are not full-grown until they are a year and a half old. It is noted that in every litter one or the other sex predominates in numbers, there being rarely half of them males and the other half females. If taken in hand when their eyes are first open, they are readily tamed; they should not subsequently be allowed to remain with the mother or in each other's society. By continual petting and handling, they become like domestic ratters, and have all the playfulness of the young of the feline tribe. They may be handled, without fear of their sharp teeth, but they prove extremely mischievous, their scent leading them to food not intended for them. Their fondness for bathing will prompt them to enter a tea-kettle or any open vessel; and when wetted they will roll and dry themselves in a basket of clothes fresh from the laundry, or even upon a lady's dress, occasioning much inconvenience.

Minks are not burrowing animals in a state of nature, but freely avail themselves of the holes of Muskrats and other ver-

min. They cannot climb a smooth surface, but ascend readily where there is roughness enough for a nail-hold. The grown male will weigh about two pounds; the female is heavier than she looks, averaging between one and a half and one and three-fourths pounds. These tame Minks make excellent ratters, hunt vigorously, and soon exterminate the troublesome pests. Rats will make off on scenting them, they are so bewildered in flight that they give no battle, but yield at once; and the Mink severs the main vessels of the neck so quickly and skilfully that an observer would scarcely imagine the deed had been done.

When wild Minks are confined with the tame ones, the latter always prove stronger than the former, and come off victorious in the contests that ensue. They have been observed to beat off a cat that imprudently invaded the minkery in quest of food. So completely domesticated are the animals that a person may enter the inclosure with impunity, and observe the animals playing about him like kittens.

Mr. Resseque states that he finds ready sale for his Minks—in fact, that he cannot supply the demand. His prices are $30 per pair—$20 for a female, $10 for a male, and $25 for an impregnated female. It is to be hoped that this novel branch of industry will be perpetuated and extended. There are plenty of Minks in this country, the services of which are available without difficulty for the purpose of destroying vermin, and in the aggregate their good services would have a very decidedly appreciable result. They have a great advantage over terrier dogs in being able to enter any ordinary rat-hole and drive their prey from its hidden resorts.

From the "Forest and Stream" of July 2, 1874, the following article is extracted in further illustration of this branch of industry:—

"Messrs. Phillips & Woodcock, of Cancadea, New York, commenced two years ago the business of breeding Mink for their fur. A correspondent of the Buffalo Express describes the 'Minkery' in the following terms:—

"'The "Minkery," designed to accommodate one hundred Minks for breeding, consists first of an enclosure about forty feet square, made by digging a trench one foot deep, laying a plank at the bottom, and from the outer edge starting the wall, which consists of boards four feet high, with a board to cap the top, projecting upward eight or ten inches to prevent their climbing over. Within this enclosure is a building 14 by 24, supplied by

running water, from which the Mink catch living fish, that are often furnished, with the greatest delight.

"'The building is constructed by an alley three feet wide around its circumference. Within are two rows of cells four feet deep and two and a half wide, each having a door ventilated at the top and bottom with wire screens, as is also the front entrance, what the proprietors call the anteroom, four by four feet, which must be fastened within every time the building is entered, to prevent the escape of the imprisoned animals. On entering the main hall, which the Minks have access to (when not rearing their young), they present a very playful group.

"'The person feeding them is often mounted, for their food and their tenacity of hold is so strong that they may be drawn about or lifted without releasing their hold upon the food. The nest of the female is very peculiarly constructed with grass, leaves, or straw, with a lining of her own fur so firmly compacted together as to be with difficulty torn in pieces. The aperture leading to the nest is a round opening, just sufficient to admit the dam, and is provided with a deflected curtain, which covers the entrance and effectually secures her against all invasion when she is within. About the middle of March the females are separated from the males until the young are reared. The necessity for this arises from the fact that the males seem inclined to brood the young almost as much as the dam, when both are permitted to remain together.

"'The expense of feeding these animals is almost nominal, being supplied pretty much entirely from the usual offal of a farm yard, with occasional woodchucks and game in general. They eat this food with equal avidity after decomposition has taken place, devouring every particle of flesh, cartilage, and the bones. The flesh and bones entire of the woodchuck are consumed often at a single meal. While the expense of keeping is thus trivial, the profitable yield of the animal is comparatively immense, it being considered a moderate estimate or claim that the Mink with her increase will equal the avails of a cow.'"

We find in Audubon and Bachman several paragraphs upon the same subject, which will be transcribed:—"The Mink, when taken young, becomes very gentle, and forms a strong attachment (?) to those who fondle it in a state of domestication. Richardson saw one in the possession of a Canadian woman, that passed the day in her pocket, looking out occasionally when its attention was roused by any unusual noise. We had

in our possession a pet of this kind for eighteen months; it regularly made a visit to an adjoining fish pond both morning and evening, and returned to the house of its own accord, where it continued during the remainder of the day. It waged war against the Norway rats which had their domicile in the dam that formed the fish-pond, and it caught the frogs which had taken possession of its banks. We did not perceive that it captured many fish, and it never attacked the poultry. It was on good terms with the dogs and cats, and molested no one unless its tail or foot was accidentally trod upon, when it invariably revenged itself by snapping at the foot of the offender. It was rather dull at midday, but very active and playful in the morning and evening and at night. It never emitted its disagreeable odour except when it had received a sudden and severe hurt. It was fond of squatting in the chimney corner, and formed a particular attachment to an armchair in our study.

"The latter end of February or the beginning of March, in the latitude of Albany, N. Y., is the rutting season of the Mink. At this period the ground is usually still covered with snow, but the male is notwithstanding very restless, and his tracks may everywhere be traced, along ponds, among the slabs around sawmills, and along nearly every stream of water. He seems to keep on foot all day as well as through the whole night. Having for several days in succession observed a number of Minks on the ice hurrying up and down a millpond, where we had not observed any during the whole winter, we took a position near a place which we had seen them pass, in order to procure some of them. We shot six in the course of the morning, and ascertained that they were all large and old males. As we did not find a single female in a week, whilst we obtained a great number of males, we came to the conclusion that the females, during this period, remain in their burrows. About the latter end of April the young are produced. We saw six young dug from a hole in the bank of a Carolina rice field; on another occasion we found five enclosed in a large nest situated on a small island in the marshes of Ashley river. In the State of New York, we saw five taken from a hollow log, and we are inclined to set down that as the average number of young the species brings forth at a time."

The following extract from a letter from Dr. T. S. Roberts, gives a vivid account of an episode in the life of the mink:

"Passing through a tamarack swamp, December 7th, 1877, I came upon a trail in the snow made apparently by the body of

some small animal while being dragged along. My curiosity being aroused, I followed it a short distance out from among the tamaracks into the bushy meadow adjoining. Here I came upon a place where the snow had been beaten down in a circular spot, the weeds and bushes having been lashed about—evidently the scene of an encounter of some kind. Going a few steps farther, I found there were now two tracks, one made by a rabbit in full run, and the other by some small animal, evidently a mink. The pursuit had been a hot one, and the mink had showed his cunning by keeping a little to one side of the rabbit that he might take advantage of any curve or turn made by the latter. Having learned this much, I turned about and followed the trail made by the body of the captured rabbit. Straight into the middle of the tamarack swamp it went, to a small stream flowing in a narrow, ditch-like channel. Here on the frozen stream I found the rabbit dragged into a narrow place between the banks of the ditch. It was the little grey rabbit (*Lepus sylvaticus*). A round hole just back of the ear on the left side, showed how the life blood had been drawn.

Near this creek I noticed other places where this mink had been chasing rabbits, but without success. A short distance up the creek I found where another rabbit had been dragged into the ditch, but it was not frozen here, and the body could not be found."

The following observations given by Prof. C L. Webster* may serve to give some insight into the domestic habits of the mink. Opportunities for such observation are, unfortunately, exceedingly rare in all the fur-bearing animals, and the present case may serve as a foil to the less pleasant picture afforded by Dr. Roberts, of the disposition of another member of the same group:

"While engaged in geological work on the Cedar river, near Osage, Iowa, my attention was attracted by the peculiar actions of a mink (*Putorius vison*). By careful maneuvering we were enabled to approach to within a short distance of where it was engaged, and there watch its behavior unobserved. It was an old mother mink engaged in fishing for her young. On the ripples in the centre of the stream, where the water was not more than two feet in depth, was a flat drift boulder rising a few inches above the surface. On this rock the mother mink would take her position and here watch for small fish to approach,

*Am. Naturalist. March, 1889, p. 176.

when she would dive into the water, be gone for a moment and then reappear on the opposite side of the rock, usually with a fish in her mouth, which she would deposit in the centre of the stone, and its struggles instantly stop by a quick, sharp bite back of the head, which caused immediate death. This process was repeated without intermission, except to stop for an instant to shake the water from her furry coat, until seven fish, varying from four to seven inches in length, were deposited upon the rock. Then, without stopping to rest, taking one fish in her mouth, she plunged into the stream and swam ashore, climbed up the steep bank and ran hastily to her young, in a burrow under an old stump on the bank of the stream, fifty yards away. In a moment she was seen returning, plunged into the stream and swam to the rock, took a second fish in her mouth, entered the river once more, and returned to her young as at first. This was repeated until all the fish had been carried away. A few moments after having removed the last fish, she returned and began her work once more. This time, however, her labors were without result; so, shifting her position to another rock in the stream a short distance away, she continued her fishing. But, although more than a quarter of an hour was spent in energetic effort, her labors were without avail, and she was this time compelled to return to her young empty handed."

"From the bank of the stream, where egress from the water was made, to the burrow, fifty yards distant, a well beaten path had been formed by the mother mink in her daily excursions in quest of food for her young."

Subfamily LUTRINÆ.

THE OTTERS.

Several closely allied subgenera of aquatic *Mustelidæ* constitute this group, which is represented in most parts of the earth, but in North America by but a single species. The elongated body is supported on very short limbs. The neck is not as long as in the weasels, and the tail is tapering and flattened. The dentition is highly carnivorous, i. $\frac{6}{6}$, c. $\frac{1}{1}$, p m. $\frac{4}{3}$, m. $\frac{1}{2}$ x 2=36. In the genus *Lutra* the skull is much depressed and flattened on top, the dorsal outline being nearly straight. The rostral portion is short. The palate extends beyond the molars, anteorbital foramen very large. The pterygoids are hamular.

Lutra canadensis Cuv.

OTTER.

(Plate XIX.)

Lutra canadensis most earlier writers.
Latax canadensis Gray.
Lutra hudsonica F. Cuv.
Lutra lataxina F. Cuv.
Lataxina mollis Gray.
Lutra californica Baird.

Coues gives the following diagnostic points: "Orbits well defined by prominent conical postorbital processes, the distance between the tips of which is one-half or more of the intermastoid width of the skull. Inner depressed moiety of posterior upper premolar as large and nearly as long as the main outer moiety; general dentition strong, nose pad large."

The otter is frequently over four feet in length, the tail measuring about eighteen inches. The head is rounded and short-muzzled, the eyes and ears being small, the former being half way to the snout. The fur is very dense and glossy, the under fur being close and abundant. The feet are almost completely webbed. The color is a dark rich brown with a purplish cast, darkest on the back and root of the tail. The female is similar to, but smaller than the male.

The otter was distributed throughout the United States in suitable locations though now becoming rare in all but remote districts. A few individuals seem still to cling to their old haunts in many places. In Mexico a slightly different species or variety exists and in South America a still different form. Although the otter is not rare in many parts of Minnesota, no specimen has been encountered in the field explorations nor yet authentic indications of its presence. I am again constrained to quote from Coues' Mustelidæ. pp. 313-319.

Habits of Otters.

Although I have observed the "seal" of the Otter and its curious "slides" in various parts of our country during the years I have been a student of our animals, I cannot truly aver that I have ever laid eyes upon a living individual; and to speak of its habits, I must give information at second hand. Presuming upon the reader's knowledge of the thoroughly aquatic and highly piscivorous nature of the animal, I turn to the various histories at our disposal in further elucidation of its habits.

According to Richardson, one of the earliest authors giving accounts of the species with precision, "the Canada Otter resembles the European species in its habits and food. In the winter season, it frequents rapids and falls, to have the advantage of open water; and when its usual haunts are frozen over, it will travel to a great distance through the snow, in search of a rapid that has resisted the severity of the weather. If seen, and pursued by hunters on these journies, it will throw itself forward on its belly, and slide through the snow for several yards, leaving a deep furrow behind it. This movement is repeated with so much rapidity, that even a swift runner on snow-shoes has much trouble in overtaking it. It also doubles on its track with much cunning, and dives under the snow to elude its pursuers. When closely pressed, it will turn and defend itself with great obstinacy. In the spring of 1826, at Great Bear Lake, the Otters frequently robbed our nets, which were set under the ice, at the distance of a few yards from a piece of open water. They generally carried off the heads of the fish, and left the bodies sticking in the net.

"The Cannada Otter has one litter annually, about the middle of April, of from one to three young."

In the Middle and Southern States, Audubon says they are about one month earlier.*

The sliding of the Otter, which Sir John describes, is not alone resorted to in the endeavor to avoid pursuit; and again, it is something more than simply an easy way of slipping down a wet sloping bank into the water. It seems to be a favorite amusement of this creature, "just for fun." Godman speaks of the diversion in the following terms:—"Their favorite sport is sliding, and for this purpose in winter the highest ridge of snow is selected, to the top of which the Otters scramble, where, lying on the belly with the fore-feet bent backwards, they give themselves an impulse with their hind legs and swiftly glide head-foremost down the declivity, sometimes for the distance of twenty yards. This sport they continue apparently with the keenest enjoyment until fatigue or hunger induces them to desist."

Statements of similar import are made by various writers, and accord with Audubon's personal observations, as rendered by him in the following language:—

*According to Bell, the European Otter goes with young nine weeks, and produces three to five young ones in March or April (Brit. Quad. 1837, 136). The period of gestation of our species, if different, probably remains to be ascertained.

"The Otters ascend the bank at a place suitable for their diversion, and sometimes where it is very steep, so that they are obliged to make quite an effort to gain the top; they slide down in rapid succession where there are many at a sliding place. On one occasion we were resting ourself on the bank of Canoe Creek, a small stream near Henderson, which empties into the Ohio, when a pair of Otters made their appearance, and not observing our proximity, began to enjoy their sliding pastime. They glided down the soap-like muddy surface of the slide with the rapidity of an arrow from a bow, [*] and we counted each one making twenty-two slides before we disturbed their sportive occupation.

"This habit of the Otter of sliding down from elevated places to the borders of streams, is not confined to cold countries, or to slides on the snow or ice, but is pursued in the Southern States, where the earth is seldom covered with snow, or the waters frozen over. Along the reserve dams of the rice fields of Carolina and Georgia, these slides are very common. From the fact that this occurs in most cases during winter, about the period of the rutting season, we are inclined to the belief that this propensity may be traced to those instincts which lead the sexes to their periodical associations."

The food of the Otter, and the manner in which it is procured, are noted by the same author in the following terms:—

"The Otter is a very expert swimmer, and can overtake almost any fish, and as it is a voracious animal, it doubtless destroys a great number of fresh water fishes annually. We are not aware of its having a preference for any particular species, although it is highly probable that it has. About twenty-five years ago we went early one autumnal morning to study the habits of the Otter at Gordon and Spring's Ferry, on the Cooper River, six miles above Charleston [S. C.], where they were represented as being quite abundant. They came down with the receding tide in groups or families of five or six together. In the space of two hours we counted forty-six. They soon separated, ascended the different creeks in the salt marshes, and engaged in capturing mullets (*Mugil*). In most cases they came to the bank with a fish in their mouth, despatching it in a minute, and then hastened back again after more prey. They returned up the river to their more secure retreats with the rising tide. In the small lakes and ponds of the interior of Carolina, there is found a favourite fish with the Otter, called the fresh-water trout (*Grystes salmoides*).

*[A statement certainly too figurative for literal acceptation.]

"Athough the food of the Otter in general is fish, yet when hard pressed by hunger it will not reject animal food of any kind. Those we had in confinement, when no fish could be procured were fed on beef, which they always preferred boiled. During the last winter we ascertained that the skeleton and feathers of a wild duck were taken from an Otter's nest on the banks of a rice field reserve-dam. It was conjectured that the duck had either been killed or wounded by the hunters, and was in this state seized by the Otter, ...

"On throwing some live fishes into a small pond in the Zoological Gardens in London, where an Otter [presumably, however, of another species] was kept alive, it immediately plunged off the bank after them, and soon securing one, rose to the surface holding its prize in its teeth, and ascending the banks, rapidly ate it by large mouthfuls, and dived into the water again for another. This it repeated until it had caught and eaten all the fish which had been thrown into the water for its use. When thus engaged in devouring the luckless fishes the Otter bit throught them, crushing the bones, which we could hear snapping under the pressure of its powerful jaws."

The nest of the *European* Otter is said to be formed of grass and other herbage, and to be usually placed in some hole of a river's bank, protected either by the overhanging bank or by the projecting roots of some tree. Its fossorial ability, and the general intelligence it displays in the construction of its retreats, have been greatly exaggerated by some writers, to judge by the more temperate language used by the distinguished author of the *History of British Quadrupeds.* "We read of its excavating a very artificial habitation," says Bell, "burrowing under ground to a considerable distance; making the aperture of its retreat always under water, and working upwards, forming here and there a lodge, or dry resting-place, till it reaches the surface of the ground at the extremity of its burrow, and making there a breathing-hole, always in the middle of a bush or thicket.[*]. This statement is wholly incorrect. The Otter avails itself of any convenient excavation, particularly of the hollows beneath the overhanging roots of trees which grow on the banks of rivers, or any other secure and concealed hole near its fishing haunt; though in some cases it fixes its retreat at some distance from the water, and when driven by a scanty

*[The author remarks the similarity of such an account with that given by Mr. George Bennett in describing the retreats of the *Ornithorhynchus* of Australia, though the former is found in books published long prior to the discovery of the latter animal.]

supply of fish, it has been known to resort far inland, to the neighbourhood of the farm-yard, and attack lambs, sucking pigs, and poultry,—thus assuming for a time the habits of its more terrestrial congeners." I am not aware that such extravagant statements have been made, with any authority at least, respecting the American Otter; and indeed one has only to regard the general configuration of the animal, and particularly the shape of the fore limbs and condition of the claws, to become convinced that the mining operations of the animal are necessarily limited. It does not appear that the underground retreats of the Otter are constructed with the skill and ingenuity of even those of the Muskrat. A retreat examined by Audubon has been thus described by this author:—

"One morning we observed that some of these animals resorted to the neighbourhood of the root of a large tree which stood on the side of the pond opposite to us, and with its overhanging branches shaded the water. After a fatiguing walk through the tangled cane brake and thick under-wood which bordered the sides of this lonely place, we reached the opposite side of the pond near the large tree, and moved cautiously through the mud and water to its roots: but the hearing or sight of the Otters was attracted to us, and we saw several of them hastily make off at our approach. On sounding the tree with the butt of our gun, we discovered that it was hollow, and then having placed a large stick in a slanting position against the trunk, we succeeded in reaching the lowest bough, and thence climbed up to a broken branch from which an aperture into the upper part of the hollow enabled us to examine the interior. At the bottom there was quite a large space or chamber to which the Otters retired, but whether for security or to sleep we could not decide. Next morning we returned to the spot, accompanied by one of our neighbours, and having approached and stopped up the entrance under water as noiselessly as possible, we cut a hole in the side of the tree four or five feet from the ground, and as soon as it was large enough to admit our heads, we peeped in and discovered three Otters on a sort of bed composed of the inner bark of trees and other soft substances, such as water grasses. We continued cutting the hole we had made larger, and when sufficiently widened, took some green saplings, split them at the but-end, and managed to fix the head of each animal firmly to the ground by passing one of these split pieces over his neck, and then pressing the stick forcibly downwards. Our companion then crept

into the hollow, and soon killed the Otters, with which we returned home."

Their structure being identical, the American and European Otters cannot differ in their general movements and attitudes. In speaking of the conformation of the latter species, Bell remarks that evidently every facility consistent with the preservation of its structural relations with the rest of the group is given to the Otter for the pursuit and capture of its proper food. "It swims and dives with great readiness and with peculiar ease and elegance of movement; and although its action on land is far from being awkward and difficult, yet it is certainly in the water that the beautiful adaptation of its structure to its habits is most strikingly exhibited. It swims in nearly a horizontal position, and dives instantaneously after the fish that may glide beneath it, or pursues it under water, changing its course as the fish darts in various directions to escape from it, and when the prey is secured, brings it on shore to its retreat to feed."

Yielding a pelt of great beauty and value, from the exquisite softness and rich warm color of the fur, as well as from the size of the animal, the American Otter is systematically pursued by professional trappers. I have already given some figures showing the thousands annually destroyed, and will condense from Mr. Gibson's work, already often quoted, the account of the various methods employed—for every trapper has his own notions and ways of doing things, and in the pursuit of so valuable and so wary a creature as the Otter there is room for large and varied experience. The animal seems to be taken in this country usually, if not invariably, with the steel trap, a special size and make of which, with two springs, goes by the name of "Otter trap." Searching for a "slide," or place where the animal habitually crawls from the water up the bank the hunter sets the trap on the spot, a few inches under water. No bait is here required; and devices are used in securing the trap by which the animal may be led into deep water when caught, or lifted upward, the design in either case being to prevent the animal's escape by gnawing off the imprisoned limb. The trap may also be placed at the top of the slide, two or three feet back of the slope, in a place hollowed to receive it, and covered with snow. Under such circumstances, care is taken not to handle the trap with the bare hands. It is scented with various animal odors, and, to further insure success, a "way" is made to the trap by means of

parallel logs. The trap is sometimes simply set in the beaten track made in the snow, carefully hidden; or at the entrance of the burrow; or at the base of a slanting log with one end under water, the Otter being attracted by bait or odor placed beyond on the other end; or a rock which projects over a stream is utilized in the same way. In all these methods, the utmost care is necessary to obliterate traces of the trapper's presence, as the sight and smell of the Otter are acute, and his wariness, caution, and sagacity at a very high rate. "In winter when the ponds and rivers are frozen over the Otters make holes through the ice at which they come up to devour their prey. Where the water is a foot deep beneath any of these holes the trap may be set in the bottom, the chain being secured to a heavy stone. When the Otter endeavors to emerge from the hole he will press his foot on the trap and thus be caught. If the water is deep enough beneath the hole the trap may be baited with a small fish attached to the pan, and then carefully lowered with its chain and stone to the bottom. For this purpose the Newhouse, No. 3, is best adapted, as the Otter is in this case caught by the head."

Family URSIDÆ.

THE BEARS, RACCOONS, ETC.

This very large and interesting family is represented within our limits by two species representing the two sub-families. The family is distributed over all parts of the globe where any species of Carnivora occur and is represented by a large number of quite diverse species. The common characters are as follows: Progression plantigrade, soles naked (except in *Ailurus*), toes five on each foot, sometimes more or less webbed and usually large curved and non-retractile though some species have more or less retractile claws. The body is usually clumsy and heavy, though there are exceptions to this. All the species with a few exceptions, which live in arctic or treeless regions, climb readily and some spend their lives in arboreal habitats. The bears as a group are omniverous and the teeth, although identical in number with those of the *Canidæ*, are remarkable for their adaptation to an omniverous diet.*

There are, however, a few in this family, like the *Ursus marinus*, or polar bear, which live exclusively upon flesh and

*(Baird unaccountably says—on page 206 of the Report of the Northern Pacific R. R., Mammals—"The teeth are the same in number with the Canidæ, although their more carniverous character is shown by the turberculated molars." Perhaps the word carniverous is a misprint for omniverous, for neither the habits of the animal nor ordinary analogy substantiate the statement as it stands.)

others which are nearly confined to a vegetable diet, intermediate conditions linking these extremes.

There are from forty-two to thirty-six teeth and two molars are always present in the upper and lower jaw, while in *Ursus* a third molar is found in the lower jaw. The crowns of the molars are tuberculate, the prominences in some cases being high and sharp, but in true bears are low and the crown is also marked by various wrinkles and elevations. These teeth are in many respects not unlike the molars of swine. There are normally four pre-molars in each jaw as in *Ursus*, *Ailuropus*, *Procyon*, *Nasua* and *Bassaris*. In *Ailurus* there are but three in the upper jaw, while a like reduction is also found in the lower jaw of *Arctictis* and *Cercoleptes*.

There is a tendency to reduce the number of pre-molars with age. In the true bears these teeth are reduced in size and have conical crowns, while the smaller members of the family have sharp triangular middle lobes. The incisors and canines have the form common to Carnivora and are often of great size.

The nearest relatives now living are the Civet cats which some of the smaller forms greatly resemble. The plantigrade walk, which is perhaps the most marked peculiarity of bears, is also found among certain *Viverridæ*, while there are a few of the *Ursidæ* which have retractile claws.

The two sub-families are well marked and distinct groups. The *Subursinæ* include the long-tailed, small-bodied forms, almost confined to America. The number of teeth is never more than forty (except in the aberrant *Æluropus*.)

The *Ursinæ* include, besides *Ursus* proper, several species of tropical bears.

The *Prochilus labiatus* inhabits Ceylon and India and is characterized by its long, flat head, overhanging lips and protrusible snout and the long, curved claws. It is arboreal and lives largely upon honey.

A still better climber is the sun bear, which inhabits the Sunda Islands, etc., and is vegetarian in habit and is particularly partial to the cocoanut.

Subfamily SUBURSINÆ.

This group is composed of several genera of small animals represented in North America by the raccoons or lavatory bears. The genera are more strictly localized than in the larger division of the *Ursidæ*, but as a whole the group is

widely distributed. The characteristics of the *Subursinæ* differ from those of the typical ursine particularly in a reduction of the number of teeth. Externally the appearance is rendered less bear-like by the presence of a long, hairy, and sometimes prehensile tail. The true bears possess 42 teeth, while their smaller relatives have 36 – 40, the chief variation being in the molars and premolars. The *Subursinæ* are plantigrade, and have a free use of the fore feet, most species using them with great dexterity in feeding, etc. The species are arboreal, and chiefly nocturnal, and bear confinement and even domestication well.

These like other ursine animals are omnivorous. Insects, birds, and especially their eggs, are particularly relished, though fruits, roots and other vegetable food is not declined. Some species exhibit their relation with the familiar *Ursus* by a penchant for honey.

A connection with the cats seems to be offered by a South American animal, the *Bassaris astuta*, which has been classed with the Civet cats (*Viverridæ*). Indeed, this animal has been placed in that group by some authors. Although said by Vogt to inhabit Mexico, Southern California and Texas, American authors seem not to have noticed its occurrence in the United States.

On the other hand, the link between the small bears and *Ursus* is found in *Ailuropus*, a curious bear-like animal, confined in its range to the inaccessible mountains of eastern Thibet. This animal is but partially plantigrade, touching the ground with but part of the sole. In size it approaches the true bears, but in many points resembles the panda (*Ailurus fulgens*), which is described as a pretty arboreal and frugivorous animal, 35 centimeters long. The panda inhabits the Himalayas above 6,000 feet. The cat-like head with its ruffled cheeks, the fine reddish fur, and the long tail, make it a striking animal. Its food is chiefly fruit.

Curiously enough we encounter another representative of the group in the Sunda Islands in the *Arctictis binturong*. The dog-like head, lynx-like ears and monkey-like tail make a strange combination, as may be gathered from the outline sketch (see Fig. 9 [3]). The claws are not retractile, but the food largely consists of flesh. The tail is used for prehension. The nearest relative to this creature must be sought in South America where we find the *Cercoleptes*, in which the tail is used

almost as freely as in the American monkeys (Fig. 9 [2]). This animal is described as most affectionate and confiding in confinement. Like the raccoon it is very "handy" in the use of its fore feet.

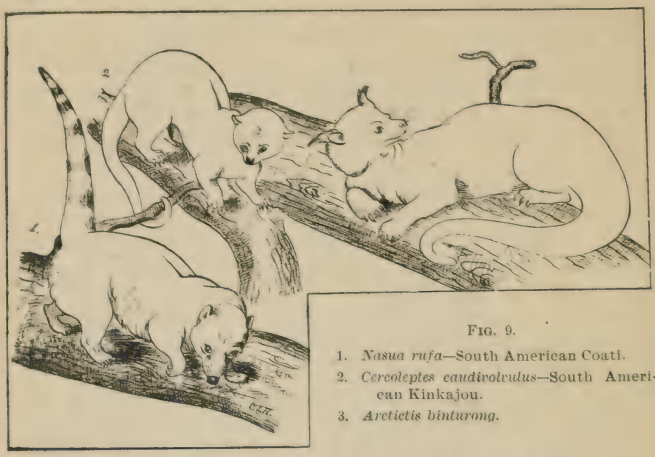


FIG. 9.

1. *Nasua rufa*—South American Coati.
2. *Cercoleptes caudivolvulus*—South American Kinkajou.
3. *Arctictis binturong.*

Still another South American animal may be mentioned to show the connection between the above and the raccoons, to the consideration of which these remarks are introductory. The coati (*Nasua*) (Fig. 9 [1]), are much less tractable and pleasing pets. They are described as the vagabonds of their native land which includes all South and part of North America. They climb and run with equal ease and are as much at home when rooting with their long snout in the earth as when ransacking the nest of an unfortunate bird. The males seclude themselves save in the breeding season. The dentition of the coati is almost identical with that of the raccoons.

GENUS PROCYON (RACCOONS.)

As lack of material prevents from offering any comparisons with related genera, the reader is referred to the description of our only species for points in the anatomy diagnostic of this genus.

The dental formula for the genus is as follows:

$$\text{I.}\ \frac{3-3}{3-3},\ \text{c.}\ \frac{1-1}{1-1},\ \text{p m.}\ \frac{4-4}{4-4},\ \text{m.}\ \frac{2-2}{2-2} = 40.$$

The variation in the number of molars and premolars in related genera is as follows:

Ailuropus : p m. $\frac{4-4}{4-4}$, m. $\frac{2-2}{3-3}$, = 42.

Ailurus: p m. $\frac{3-3}{4-4}$, m. $\frac{2-2}{2-2}$ = 38.

Arctictis, Cercoleptes: p m. $\frac{3-3}{3-3}$, m. $\frac{2-2}{2-2}$ = 36.

Procyon, *Nasua*, *Bassaris*: p m. $\frac{4-4}{4-4}$, m. $\frac{2-2}{2-2}$ = 40.

The *Ursinæ* agree with the *Ailuropus* in the number of teeth.

The head is broad and depressed, the muzzle being pointed and the nose produced. The ears are moderate, rounded, not pointed above. The feet are all five-toed and the toes are distinct. The impression made by the hind foot when the heel is applied to the ground, as is not always done in walking, is almost exactly like that of a human infant. There are no pads or callosities. The tail is longer than one-half the body and covered with long hairs. The Raccoons always have dark marks about the face, and bands encircling the tail. The three known species are confined to America; they are *P. lotor*, inhabiting the Eastern United States westward to Texas, Wyoming, etc.; *P. hernandezii*, occupying the western coast of the United States, Mexico and Central America; and *P. cancrivorus* from South America. Other species have been described, but seem not to be valid. The three species are so similar that the anatomical characters of *P. lotor* may be considered of generic application.

Procyon lotor LINN.

RACCOON.

Ursus lotor, older writers.
Procyon lotor, STORR and later authors.

About the size and nearly the general color of the badger. Head broad and depressed, the muzzle being acute; ears large, rounded above, hairy. General color grayish white or yellowish brown. An oblique dark patch on the cheeks. Tail bushy with four or five dark rings. Entire length over thirty-two inches, the tail being one-third.

Generally distributed in the United States east of the Rocky Mountains.

The raccoon ranges over the entire wooded parts of our state and is well known for its depredations upon the farmer

and the poultryman. The habits are tolerably well known. It is instructive to watch the *Procyon* in confinement, which is readily endured, for the amiable and inquisitive pet exhibits many of his native characteristics. There is something quite human in the way the claws are used, although the expression of the face and many of the attitudes and motions are quite bear-like. In fact there is a curious combination of the ludicrous clumsiness of a bear with a deftness and sprightliness peculiarly its own. Even when chained, the fore feet are kept constantly in motion examining automatically every inequality of the ground and every crevice. A rat hole or the like is al-

FIG. 10.—The Raccoon at Bay.

ways an attractive field for study. If permitted to approach the person he scrambles freely over one and searches every pocket and hem. A bit of cake or candy thus found is eagerly devoured and the search at once renewed. If furnished water all food is carefully washed, and in its absence it is carefully rubbed. The positions assumed in this process are frequently comical in the extreme. If a fragment is accidentally dropped the feet distinguish it from the pebbles on the bottom at once. When searching for a lost morsel with its feet one scarcely escapes the impression that the animal is blind, which delusion is hightened by the opaque appearance of the pupil in many lights. On the other hand, the truth is that the eyes are busily engaged in following our motions, and the animal relies on the tactile sense entirely in handling its food. At other times when provided with food it seats itself gravely or

leans against an adjacent tree and, holding the food between the hind paws, helps himself with the hands in a most business-like manner. A decided preference is shown for sweet food and corn bread is much preferred to wheaten. Potatoes when cooked are eaten with reluctance, but are skillfully pealed and broken into morsels without the assistance of the teeth. Green corn is disposed of with an instinctive and accomplished ease. Eggs are devoured with an eagerness approaching excitement. A slight crack is made with the teeth which is enlarged at one point with the claws and the contents lapped up as they exude. A boiled egg is a conundrum not readily solved and only understood when the yelk is reached. A pet raccoon was chained in my doorway for weeks till the neighboring chickens lost all fear of the intruder and partook freely of the crumbs which fell from his table. Only after

FIG. 11.—The Raccoon at Dinner.

this state of confidence was reached did he make any demonstration, and then continual depredations attested the cunning of the quadruped. Curiously enough, birds were freely eaten, but small rodents were utterly refused, so that we must conclude that these latter do not enter the regular diet of the animal in a wild state. Our raccoon passed much of its time in "jumping rope" with its hind feet, while its chain was kept taut by the neck.

The raccoon is hunted on account both of its flesh and its pelt, the latter being used considerably in the manufacture of robes and coats, and occasionally, especially in the rural districts, for other purposes. It is neither very durable nor attractive, however, and would hardly lead to the persecution which attends the animal were it not that its depredations upon the corn fields and the poultry house add the motives of revenge and self-protection to the more sportsman-like. The flesh is not despised by many, though the omnivorous, and especially the insectivorous habits of the animal render it specially subject to internal parasites in spite of the most remarkable precautions which either experience or natural taste has developed in its eating habits. An instance was seen where the body of a raccoon which had been exposed in the market with other meats, was literally filled with worms of the genus *Filaria* several inches long, and these filled with living embryos in all stages of development.

The hunting of raccoons is a favorite amusement of farmers' boys, and as it is carried on at night with the aid of dogs, torches and axes, seems to be replete with an excitement hardly commensurate with the value of the prize. This sport has a peculiar fascination for the Southern negro, and the exploits of a night's 'coon hunt served to mitigate the weariness and sadness of a life of servitude.

The writer had on one occasion the opportunity of assisting in such an enterprise. It was in Northern Alabama, and the ostensible object of the hunt was an opossum which, for various reasons, the visitor was anxious to secure.

At about nine o'clock a party of boys and dogs, which constantly increased, sallied forth, animated by the occasional blasts of an old horn, this instrument being necessary to properly control the proceedings of a multitude of mongrel curs, each of which excelled in some subtlety of 'possum or 'coon lore any dog in the county. Lights were brandished and with a shout as heterogeneous as the company from which it pro-

ceeded we plunged into a swampy and tangled woodland, to the writer, at least, of unknown extent. The baying or rather yelping of the dogs in various directions kept us informed that "Tige" and "Zep," etc., were at their work. Suddenly the conclave of hunters assembled violently excited. "Zep hab struck fresh 'coon trail, shore," said one. "Go way, dar, Sandy," was the reply, "dat dog never let on dat ar way cep'en he's found 'possum tracks." In a sage discussion, involving the theory and practice of dog-education, the time was occupied until we had all assembled about the base of a tall tree which seemed the object of the most excited interest of the mongrel called "Zep." Our lights brilliantly illuminated the base and lower branches which, however, cast deep and deceptive shadows upon the spire of the noble tree. Boys and dogs were equally excited, and there were proposed and instantly rejected a variety of expedients for dislodging the unknown animal which the 'possum dog hazarded his reputation in affirming still lay concealed among the boughs. The other dogs now came up, and some immediately caught the infection and added their strangely modulated cries to the din. One, however, sniffed wisely at the scent and, shaking his head sadly, stalked off to a small sapling, large enough to support nothing heavier than a squirrel, and set up a lively opposition, gazing into the bare top of the sapling with well-feigned admiration, tearing the ground and rending the air with his deep cries. This sage conduct was the source of deep gratification to his owner, who "knowed from the first thar wan't no 'possum in that thar gum." But at last it was decided that an athletic youth should scale the tree with a gun upon his back and beard the animal in his retreat. A period of breathless silence followed by a deafening report ensued. Something struck the ground with a heavy thud and the dogs rushed up to gaze upon—the hero who had fired and brought himself, but not his game, to the ground. He reported, however, a most mammoth opossum clinging to the upper boughs. Candidates for new honors were few, but additional inducements sent another sable youth up the tree, and we were rewarded by a flash followed by a succession of snarls and spits as a heavy animal crashed earthward and landed in the midst of the group of furious dogs. Then ensued a scene more easy to imagine than to describe. Dogs and boys all eager to beat and tear the life out of the poor animal which seemed at first likely to vanquish the former if left to themselves. When the dogs had been beaten off the leader

held up a full grown raccoon which, even added to the excitement of the chase, hardly mitigated the disappointment in the failure to secure an Alabama opossum.

Description of a specimen of raccoon taken Aug. 27, 1884: This animal while young, was evidently over a year old. It throve and grew well and became a great favorite by its amiability and eccentricity.

The moult was in progress or rather nearly completed at this time. The old hair comes out in bunches, (*i. e.* the under fur), and was replaced by a darker shade. The fur was, of course far from being as full, long and strikingly colored as in winter.

The colors are as follows: Base of fur light sepia brown or a somewhat warmer tint. This ground color affects the external appearance little, except below where it is less completely obscured by the terminal part of the hairs. It does, however, tone down the external coloration everywhere. The general grey of the body is produced by the color of the longer and coarser hairs which have a median portion of white or light, but impure olivacious yellow and a longer or shorter terminal portion of dark brown or black. The chief difference between a winter and summer pelage is produced by the greater length of the dark terminal portion in the former. Underneath the terminal band is lacking and the color, except on the throat, is pure white upon the plumbeous or brown color of the under fur. Above the middle band of the hairs is distinctly yellowish and along the back the black tips are conspicuous and in winter give the appearance of a dark median stripe or band.

Upon the head are distinct markings consisting of the following dark areas on a white ground. A median band of yellowish brown beginning on the nose and becoming blackish between the eyes, terminating upon the forehead, and a band 1¼ inches wide crossing the cheeks diagonally and including the eye. The top of the head partakes of the color of the back, but the base of the ears and an irregular spot behind them is dark. A dark band nearly meets the facial one below upon the throat. The ears are white-tipped. No other marking occurs except upon the tail where the yellowish cast is more pronounced and the lighter color is broken by rings or annulations of black. In this case there are six rings aside from the terminal pencil of black hairs. A more or less distinct garter of black or brown marks the hinder leg. The exposed part of the skin is black; elsewhere it is white.

There are three pairs of mammæ, the posterior pair being near the thighs, the second 3 inches in advance, and the pectoral pair yet 4 inches beyond.

Measurements: Length of body $22\frac{1}{2}$ inches, tail 10, end of nose to incisors $\frac{3}{4}$, end of nose to eye $2\frac{1}{16}$, end of nose to ear opening $4\frac{3}{8}$, hight of ear from inside $2\frac{9}{16}$, elbow to longest claw $7\frac{7}{8}$, palm $3\frac{1}{8}$, thumb 1, middle finger $1\frac{3}{8}$, sole of hind foot $4\frac{3}{8}$.

GENUS URSUS.

The clumsy beasts constituting this genus are sufficiently well-known to require no general description. As a group it is sharply defined although much diversity of opinion exists as to the value of the remaining divisions of the sub-family. The members of the genus *Ursus* are chiefly northern in distribution. One species (*U. ornatus*), occurs in the mountainous parts of South America. The polar bear is circumpolar and differs considerably in habits and anatomy from more southern species. The northern parts of Europe are, or were, inhabited by numerous varieties of the single species *U. arctos.* This brown bear is larger than our species and in some respects like the grizzly of the west. Carl Vogt's description of the young of this species applies equally to ours:

"Little bears are very amiable and in the highest degree comical. Clowns in every respect, unwieldly yet nimble, always ready for play or sport, sociable with every one, and to a certain extent teachable, they nevertheless evince an egotistic independence which later becomes a sullen habit. The mother cares for them with unlimited devotion; for weeks she does not leave them a moment, and remains without food in the secluded recess chosen for their reception. She teaches them to walk, to climb and to swim and defends them with courage and to the last. Although the mother covers them with caresses, coddles them warmly and endures well pleased their teasing, still she does not neglect punishment, which when needed is applied in the form of sundry slaps and ear-boxing, and even slight bites of which she is not sparing. It is even said that bears of two or three years old assist in training their younger brothers and sisters."

In the United States at least two species and numerous varieties of bear are known, and it would be presumption to attempt to discuss the value of the various specific distinctions assumed by various authors upon the basis of the slight material at the disposal of this survey.

For details concerning the anatomy the reader is referred to the description of the black bear beyond. Great variations are found in different individuals of the same species.

Ursus americanus PALLAS.

THE BLACK BEAR.

The black bear is still quite common in Minnesota; every year a number are exposed in the markets of Minneapolis. So far as observed these are nearly all of the normal black variety.

Mr. Allen remarks: "Contrary to what was formerly sup posed, bears everywhere appear to be among the most variable of mammiferous animals, not only in coloration, but in size, proportions, and in the conformation of the skull and other parts of the skeleton. Those familiar with them say it is rare to find any two alike. I am informed by my friend Mr. C. W. Bennett that he has known two cubs of the same litter, taken in one of the western states, that as they grew up, differed very materially from each other in color, one being black and the other brown. They differed widely also in form and disposition, one being docile and playful, while the other was ferocious and dangerous. The leading varieties in color of the American and European bears, as the brown and black bears, are now generally deemed to be but varieties and not species. The bears have ever been a perplexing group, and accordingly the opinions advanced by different authors respecting the number of species vary widely. Several high authorities consider the land bears of northern North America, northern Asia and Europe as forming but one, or at most two, species, among which (authorities) are Blainville and Middendorff, the latter of whom, with access to a large amount of material, has especially and most minutely investigated the subject.

Dr. Gray recognizes eight with numerous varieties and subvarieties of each.

There is a strong tendency among naturalists to consider old world bears as all distinct from those of North America, and at least to recognize two species of the latter—the grizzly bear of the west and the continentally dispersed black and brown bears. Prof. Baird gives the probable number as five, four of which he seems to consider well founded. But each of the recognized species presents so many varieties, which to a greater or less extent intergrade, that well-marked lines of distinction cannot at present be drawn."

Perhaps it is not at present allowable to claim with much assurance the existence of more than a single very variable species and a number of rather indefinite sub-species.

The distinguishing characters are osteological or external, and the two sets by no means vary coetaneously.

During the winter of 1880–81, some twenty black bears were brought into Little Falls, Morrison Co., their skins being worth from ten to fifteen dollars (Upham).

A cinnamon bear is said to have been killed near Watab in 1884.

Although so clumsy in appearance, the black bear is possessed of great strength and, especially, remarkable endurance. As the largest beast of prey found in our state, it exacts an allowance of respect, not to say fear, hardly commensurate to its peaceable and ease-loving disposition. At the time of the early explorations in Minnesota, bears appear to have been numerous and very frequently seen. The Indian, very naturally with his less effective weapons, found the bear a more formidable enemy than the European hunter, and this may account for the part the bear plays in Indian mythology and legendary lore. The habits vary with the time and place greatly and the strength of the animal is supplemented by considerable adroitness which Indian belief and hunters' imagination have exaggerated to a high degree of cunning. The deftness with which the anterior extremities are used always gives us the impression of the human skill which accompanies such motions in man, so that we tend to exaggerate the mental powers of such animals as have the power of pronation, etc., and to underestimate the intelligence which is restricted to other ways of expression. There is but one bear which is entirely carnivorous, the *Ursus arctos*, and in this case necessity is the evident cause of the departure from the otherwise universal omnivorous habit.

In summer the black bear rarely or never seeks animal food, although it is by no means refused if at hand. In spring and summer the moist, shady borders of pools and rivers afford both suitable food and covert, while impenetrable swamps and wet woods furnish secure retreats during the heat of mid-summer. Succulent roots and almost any vegetable materials are appropriated, while crawfish, and perhaps other small animals, are said to supplement this diet. Nettles and even the Indian turnip (*Arumtriphyllum*) are delicacies in the cuisine of our Bruin. In late summer the various berries growing in "open-

ings" and upland prairies allure the bear from his seclusion. Raspberries are especially esteemed and low cherry trees are broken down and the small berries greedily eaten. Like the raccoon, the bear sometimes makes inroads upon the corn-fields breaking down and otherwise destroying much more than is eaten or carried away Later in the season grapes, acorns and various nuts are eaten. In the east and south bears were not infrequently encountered while breaking off the boughs of nut-bearing trees or "lopping" as it is, in some sections, termed.

During the winter, especially at the north, animal food of a necessity supplants, to a considerable extent at least, all other, and it is then that depredations upon the barn-yard may be expected. Pigs, calves and even larger animals are carried away. It is stated that on the coast bears frequently feed largely upon fish. Bruin certainly is not afraid of water and swims easily and is no mean antagonist to a party of boatmen. The venturesome boat that approaches too near is frequently capsized by the heavy beast. During the frightful forest fires which prevail at the north it is not unusual for men who fly to mid-stream for refuge from the terrible heat to be beseiged by a bear, which craves only the privilege of resting upon the boat, but who is not safely to be allowed that demand. The craving for sweets is a well known characteristic of all bears. The natural supply is furnished by the nests of the humble-bee, or the stores which wild bees lay away in hollows of trees. A "bee-tree" is very adroitly emptied by Bruin, who cares little for the stings and angry buzzing of the proprietors.

The lumbering gait of the bear is deceptive; he really is capable of a high degree of speed, and avails himself of flight when attacked by man, unless wounded or deprived of the young. Unlike the grizzly bear, our species climbs voluntarily, and very generally betakes itself to a tree when harrassed by dogs. In other cases, or if close hauled, he rises upon his hind feet, placing his back against any convenient object, and assumes the defensive; in which case dogs and men do well to carry on warfare at a distance. The quality in a dog most to be desired is not courage, for no number of dogs are a match for a bear.

Our animal is a great lover of ease, and spends much of its time in warm weather in wallowing in the mud or sleeping in a retired haunt. In the far north bears hibernate during much of the winter, which they are said to pass in the mild pleasure of licking their paws. It is doubtful if any great amount of

nutriment is derived from this amusement, either for mind or body. The winter habitation is selected not only for its warmth, but for its seclusion, for during this period the greatest danger threatens the animal, and the hunter is constantly on the lookout for one of these dens, which may be detected by frost (caused by the breath) about the opening in the snows which bury the cavity. An upturned tree in clayey soil frequently forms a retreat just suited for the winter resort of the bear, who excavates a recess in the sheltered cave formed by the uptorn roots.

The sexes associate in the autumn, and one to four young are born after a period of six or seven weeks—say in January, (more exactly, 120 days.) Four years are required to reach maturity. Like almost all animals residing in the colder parts of America, bears are migratory to a greater or less extent. The migrations are probably hardly noticeable in our limits. Many country people believe in the existence of another species of bear known as "The Ranger", which, like the man-eating tiger, is blood-thirsty, and always gaunt and hungry. This form should be distinguishable by a star or crescent in the breast, and does not hibernate.

The young of Bruin often fall a prey to the fox or fisher.

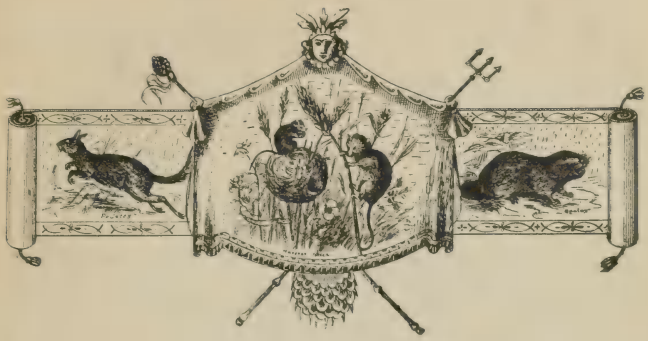
As an illustration of the winter habits of bears the following extract from an article in the "Century Magazine" of March, 1882, by Chas. C. Ward, is here reproduced. "Stimulated by the large price offered by the officers of a garrison, an Indian was indefatigable in his endeavors to find a den. One day accompanied by his little son, a boy of ten, he discovered unmistakable traces of a bear's den, near the top of a hill strewn with granite bowlders, and almostim passable from the number of fallen pines. One old pine had fallen up hill, and its upreared roots, with the soil clinging to them, formed, with a very large rock, a triangular space into which snow had drifted to a depth of ten or twelve feet. The Indian was about to pass on when he detected the whining of bear cubs. By making a detour, he reached a place on a level with the bottom of the bowlder, and there saw tracks of an old bear, leading directly into the centre of the space between the tree root and the bowlder. The old bear, in her comings and goings, had tunneled a passage under the snow drift. Getting down on his hands and knees, the Indian, with his knife held between his teeth, crept bear-fashion into the tunnel. After entering several feet he found the usual bear device—a path branching off

in two directions. While pondering what to do under such circumstances, a warning cry came from his little son, who was perched upon the top of the bowlder, and the next instant the old bear rushed into the tunnel, and came into violent contact with the Indian, the shock causing the tunnel to cave in. The Indian, after dealing the bear one blow, lost his knife in the snow, and seized the bear with his hands; but she proved too strong for him, and was the first to struggle out of the drift, when, unfortunately, she met the little Indian boy, who had climbed down to come to his father's rescue. He received a tremendous blow on the thigh from the bear's paw as she passed, which crippled him for life."

Among the native superstitions worthy of mention are the feelings of supernatural reverence with which the bear is regarded by the red man. Solemn and curious ceremonies are necessary to appease the spirit of the slain hero. The severed head is placed in a conspicuous position and is decorated with charms and ornaments of all sorts, and a formal speech is made in which, graced by all manner of compliments, the bear's pardon is asked for the rude method by which his life was sacrificed, and the hunter deferentially trusts the excuses offered may be accepted by the animal and his gens. After this, tobacco smoke is blown into the nostrils and the celebration takes on a more practical character.

Nor is this respect peculiar to Indian tribes. The northern races of Europe have like superstitions.

During the pairing season, the males congregate in troops and scour the forest, growling, snarling, and fighting. On such occasions all prudent hunters avoid an encounter with them.



CHAPTER V.

ORDER RODENTIA.

THE GNAWERS.

The Rodents are easily recognized by many points of general similarity, notwithstanding the diversity in appearance and variation in habitat. The order is the largest among mammals. The number of genera, and especially of species is enormous, and the geographical distribution is similarly extended.

While usually of small size, the animals of this order are by no means insignificant; some, like the beaver, affording a valuable fur, while others, as the hare, are prized for the food or sport furnished; and still others rank among the depredators on human stores, and are therefore universally detested. The largest rodent, the capybara, is not larger than a small hog. All rodents are plantigrade, applying the whole sole to the ground, and find their food within the vegetable kingdom. The toes are movable and generally clawed.

Rodents agree in lacking, even in the milk dentition, canine teeth—a very important and constant character. The incisors are rootless and grow during the life of the animal. They form segments of a circle, the upper being the smaller circle. The outer surface only is provided with enamel, thus providing for automatic sharpening by mutual attrition. It is interesting to notice a curious adaptation for the use of these chisel-shaped teeth in squirrels, for instance. The symphysis, or line of union of the two lower jaws, is cartilaginous only, permitting the play of the jaws laterally. By this means the teeth when inserted in the nut or acorn shell, are pried apart, splitting the shell with ease.

The incisors are frequently ornamented with ridges or corrugations. The number of molars is not large, never more than six or less than two in one ramus. The number of true molars is three, and these were not preceded by milk teeth as is usually the case with the premolars. The molars are sometimes rootless, and at others have well defined crown and roots, but the distinctions based on this circumstance are of subordinate worth. These two kinds of molars are found in closely related families, for instance among mice. The variations in the internal structure are so great as to make general statements of little value. The skull is generally elongate with well-developed premaxillæ. The orbits are not shut off from the temporal fossæ. The interparietal is well developed. There is a ninth bone in the carpus. The clavicles are present in the arboreal and fossorial groups, but absent in others. The brain surface is smooth, and the cerebrum extends but slightly backward. The digestive tract conforms to the herbiverous habits of the animals, a large cæcum being found in all but the dormice.

The nails, though generally claw-like, are occasionally modified to closely resemble hoofs ; in some cases, also, the bones of the leg are elongated and the mid-foot bones form a kind of cannon-bone, adapting the possessor to a saltatorial life, and indicating that the ungulates are not so completely distinct from the claw-bearing animals as sometimes suggested. The rodents are extraordinarily fertile, and reproduce with incredible rapidity, even though exposed to constant inroads from beasts and birds of prey. The great fecundity becomes in some cases the occasion of distress, and forced migrations, forming an interesting parallel with human history. The lemming of northern Europe has repeatedly sent southward

hordes of emigrants, which, in spite of the normally nocturnal habits of the animal, pressed on in a solid phalanx, harried on all sides by hawks and wolves, crossing rivers and facing death in a hundred forms, driven by the fiat of necessity, and thus demonstrating the Malthusian principle as applied at least to mice. The rodents attain the maximum development in South America. Thirty-two of the thirty-seven genera are restricted to that continent. The hares and squirrels constitute the most universally distributed families. Africa, similarly, is rich in endemic forms, while even the island of Madagascar has its peculiar rodent fauna. The distribution in the circumpolar continent is more general and presents fewer exceptional features. Eleven or so of the twenty-four North American genera are peculiar to this continent, and most of the restrictions and limitations are such as may be accounted for by the physical features of the land. The mice are found in all continents, even Australia having representatives. The hares and squirrels are found on all other continents, and are rather close families. East India is poorest in rodents, and for no obvious reason, so that we are forced to seek the explanation of this and other anomalies in the historical development of the order. Representatives of the genus *Myoxus*, and the squirrels have been found among Eocene fossils in Europe, and the genera continue to the present time. The Eocene of Wyoming affords remains of *Paramys* and *Sciuravus*, and in the upper Eocene the marmot-like *Plesiarctomys*.

Other species very imperfectly known are referred to uncharacterized genera, as *Colonymys*, *Taxymys*, *Tillomys*, *Mysops*, *Heliscomys*, etc. Enough, at least is known to indicate a numerous line of successors to the early Eocene rodents and to convince us that the various families were early differentiated. Mice, squirrels and porcupines have existed since the Eocene—that period so marvelously productive of new mammalia. The Miocene was the period of greatest development of the type, and it is claimed that at that time some genera now restricted to the Americas roamed over Europe. The numerous recent discoveries of paleontology leave us quite in doubt as to the primitive source of the rodent type, beyond the vague suggestion that the earliest rodent was probably a marsupial—a convenient way of dissembling sheer ignorance.

It would be interesting did our limits permit to compare the curious extremes of structure and variations in habit exhib-

ited by the rodent tribes. From the flying squirrels of West Africa, as large as a cat, to our own diminutive *Sciuropterus volucella*, from the blind mole of the Cape to our pouched gopher, from the springing mice of the Sahara to our shy *Zapus hudsonius*, there is variety enough to interest the most fastidious.

Rodents are divided into two suborders upon the structure of the teeth. The first, SIMPLICIDENTATI, includes the three series, *Sciuromorpha*, *Myomorpha*, and *Histricomorpha*, including respectively animals with resemblance and affinity to the squirrel, mouse and porcupine.

The second suborder, DUPLICIDENTATI, includes the hares and picas.

FAMILY SCIURIDÆ.

SQUIRRELS.

This family includes a variety of animals varying greatly in structure, but unmistakably related. Even the flying squirrels do not differ so essentialy from the prairie dog or woodchuck that the affinity can not easily be seen at a glance. Active and rather social and pleasing animals, for the most part, but numbering some petty raiders among them, we shall not be likely to neglect the *Sciuridæ*.

The *Sciuromorpha* have perfect clavicles, nearly free forearm bones, small incisive foramina, large and distinct malar. The nasal pad is small and the upper lip cleft. In the *Sciuridæ* post-orbital processes are present and the molars are provided with tuberculed crowns. Dental formula: i $\frac{1}{1}:\frac{1}{1}$; pm. $\frac{2}{1}:\frac{2}{1}$ m. $\frac{3}{3}:\frac{3}{3}$. The number of premolars often varies in the same genus, there being in many cases but one on a side above. The tail is hairy and generally bushy, the feet well clawed. Habits fossorial, scansorial, or partly volant. Considerable variation obtains in the configuration and minor details of the skull and skeleton, as will be seen. Eight genera are recognized, six of which occur in our district.

The squirrels constitute the genus *Sciurus*, standing at the head, while the rear is brought up by the more primitive type represented by *Arctomys*, the woodchuck. The two genera not found in America are *Pteromys* and *Xerus*, found in India and Africa respectively, the latter being in some respects like the porcupine.

GENUS SCIURUS, LINN.

Aside from obvious differences in habits, the true squirrels may be distinguished from the chipmunks and gophers by the broad head and curved dorsal outline of the skull. Skull short, broad, cranial portion expanded, facial portion rather broad; malar bone nearly vertically expanded; post-orbital process produced and slender; first premolar, if present, very small. Pelage full, tail full and bushy, back never striped, no cheek pouches. It is unnecessary to speak of the characteristics of so familiar an animal. Every one whose boyhood brought him within the influence of Nature at all must remember more than one escapade in which this furry tree-farer played an important part.

Some fourteen species occur in America, some of which are very closely allied. Our own state has but three species. Central America seems to be the focus of the genus on this continent, and here the species are not only the most numerous and variable but the largest as well. Toward the north and south the size diminishes, and a tendency is observed to depart from the typical characters of the genus. The tail especially is reduced.

The following table copied from Allen's monograph will be found useful:

SYNOPSIS OF NORTH AMERICAN SCIURI.

I. Tail very short and narrow, the caudal vertebræ alone about two-thirds as long as head and body; tail to end of hairs about one-seventh shorter than the head and body; premolars $\frac{2}{1}$, the first very small and often deciduous; a narrow, black, lateral line; size small.

1. Above greyish, mixed with yellowish or reddish, annulated with dusky, often with a strong wash of ferruginous along the middle of the back; below generally white, sometimes narrowly annulated with black; in one sub-species fulvous below. *Hab.* Northern half of North America. *S. hudsonius.*

(a). Above varied with black and yellowish-rusty; upper surface of tail with hairs gray at the base and tips, with a broad subterminal bar of black. *Hab.* Central portion of Rocky Mountains and thence westward to Sierra Nevadas.

var. fremonti.

(b). Above dusky, strongly varied with reddish; upper surface of tail with the hairs dark reddish brown at the base,

tipped with reddish, and a very broad subterminal band of black, sometimes occupying the whole of the terminal third. *Hab.* Rocky Mountains between latitude 43° and 52°, and thence westward to the Cascade Range. *var. richardsoni.*

(c.) Much as above, tail with less black, more or less tinged with fulvous or rufous below. *Hab.* Pacific Coast region from Northern California to Sitka. *var. douglassi.*

II. Tail-vertebræ about four-fifths the length of head and body; tail, with hairs, rather longer than the body, generally full and bushy. Premolars $\frac{2}{1}$ ($\frac{1}{1}$). Size large or medium.

A. Premolars $\frac{2}{1}$

2. Above whitish-gray, varied with fulvous; beneath white; middle of back more or less brownish; indistinct fulvous lateral line; ears never conspicuously tufted. *Hab.* U. S. east of plains, Canada to Guatemala. *S. carolinensis.*

Variety *leucotis* is the familiar form with the body longer than ten inches. The type of the species is smaller and inhabits the South Atlantic states, while variety *yucatanensis* is still smaller and has no rufous suffusions.

3. Above dark bluish-grey, a dorsal band of bright chestnut; a distinct black lateral line; no fulvous suffusions; below white; ears very large, tufted, frequently melanistic. *Hab.* Rocky Mountains of Colorado and Arizona. *S. alberti.*

B. Premolars $\frac{1}{1}$.

4. Color above generally some shade of grey, but extremely variable; rusty and melanistic phases prevalent; size large; tail broad and bushy. *Hab.* E. U. S. to the plains. *S. niger.*

(a). Length 13 inches; nose and ears white; below generally fulvous or rufous; dusky phases frequent. *Hab.* South Atlantic and Gulf states. *var. niger.*

(b). Smaller; nose and ears not white. *Hab.* North Atlantic states. *var. cinereus.*

(c). Above dusky grey, strongly suffused with rufous; ears, feet and ventral surface fulvous, varying to rufous; occasionally dusky or black beneath. *Hab.* Mississippi basin. *var. ludovicianus.*

III. Tail-vertebræ alone equal to length of head and body; size large; premolars $\frac{2}{1}$.

5. Above dark, pure grey, beneath white; tail black, washed with white. *Hab.* Pacific Coast west of Coast Range. *S. fossor.*

Sciurus hudsonius PALLAS.

CHICKAREE.

This pleasant but spiteful little squirrel, which is the most common member of the genus in Minnesota, is found abundantly wherever trees afford it the necessary conditions. It is not found upon the prairies but follows the sparsely timbered river valleys, even to Big Stone lake, though rarely. Its merry chir-r-r-r-r is the first greeting to the traveler, along the openings bordering the "Big Woods," and it is frequent in the northern parts of the state. It measures 6.00–7.50 to the root of the tail which is 6–7; head about 2; ear 1.50. Color, above grayish fulvous with a broad dorsal band of red. Under parts white or grey. The tail is colored as the back but its long hairs have a black band and yellowish tips. The upper surfaces of the feet vary with the seasons and age, being either of the same color as the back or of a golden orange, often particolored during the moult. The black lateral line seems also to be a seasonable character. The ears are blackish and have small pencils in winter. The feet are furry below in winter. The northern regions furnish larger specimens than farther south. In Minnesota the coloration and to some extent the size is very variable and would appear not to afford any indication of geographical variation.

The chickaree is strictly arboreal and does not hybernate. Its food normally consists of nuts and grains, but it delights to vary this diet with animal food occasionally and commits depredations upon the nests of various birds eating the young birds with a relish. It is thought by woodsmen that this active squirrel drives out the gray squirrel or harrasses it until it is glad to leave the territory claimed by it. The winter store is said to be collected in several places rather than in a single storehouse, as in the case of the chipmunk. Like the larger species, the red squirrel collects leaves and grass in the branches forming a nest for protection against cold during severe weather.

The young are cared for in hollow trees until able to care for themselves.

Sciurus carolinensis, var. leucotis GAPPER.

GRAY OR BLACK SQUIRREL.

The gray squirrel is locally rather abundant in Minnesota, and is gaining rather than loosing as settlement continues. Color,

clear whitish-gray, with a dorsal area of yellowish-brown. Under parts white; sometimes jet black, with all intermediate phases. Hairs of the tail white-tipped, with a subterminal band of black, and black annulations upon the brownish basal portion. Lower parts rarely suffused with rufous. Ears generally with a tuft of white behind at the base, not penciled. Length, 10.50; tail, 11.50; tail vertebræ, 8; fore foot, 1.75; hind foot, 2.50. As a rule the males seem to be larger, but perhaps there is no sexual variation. The top of the head is generally clear, dark-gray, while often there is a lateral yellowish line.

It is curious that the melanistic phases seem to be local and confined to narrow limits.

The southern variety of this species is considerably smaller and decidedly less white. The two varieties pass into each other. Variety *leucotis* extends throughout the northern United States and southern Canada westward to the eastern border of the plains, and southward to the isotherm of 56° F.

Sciurus niger Linn.

FOX SQUIRREL.

PLATE VIII.*

The varietal distinctions set up for the various phases of this species are of very unimportant nature. Our specimens are all of the variety *ludovicianus*. Length of body, 11–14; tail, to end of vertebræ, 8.50—10.50. Above gray, with much suffused rufous or sienna red; ears, feet and lower parts rusty red, varied with more or less dusky. The under surface is sometimes nearly black. Specimens from the far west are paler, those from the south more reddish below. The variety *ludovicianus* is confined to the area drained by the Mississippi and its tributaries.

The gray squirrel seems more common in most parts of the state, but the distribution is remarkably capricious.

Genus SCIUROPTERUS, F. Cuv.

The flying squirrels are represented in North America by but a single species extending from the Atlantic to the Pacific and subject to great geographical variation.

The skull is short, broad, and strongly curved, orbits large, interorbital region constricted, pterygoid processes slender,

*The plate is intended as an illustration of the adaptability of native animals to decorative art. The present case being a tile in which conventionalization is introduced into the accessories simply in order to highten contrasts otherwise too slight to be available for such purposes.

premolars two. Fore limb with a catilaginous spur from the carpus to which is attached the volar fascia passing like the string of a shur through the hairy fold of skin serving for flight. Fur very soft, tail with distichous pelage, ears large, eyes very large.

(My notes on this genus having been lost only a brief account of the common species is now possible.)

Sciuropterus volucella PALL.

(Plate VII.)

This beautiful species is extremely variable. The eastern United States is inhabited by the variety *volucella* which rarely exceeds 5½ inches in length of body, the tail being somewhat less. The color is a soft yellowish brown above, white or cream colored below. The middle of the back and especially the upper surface of the tail is darker than the remainder. The under pelage is plumbeous or black and this frequently appears along the edges of the wings and the terminal portion of the tail.

The species is dispersed throughout the wooded parts of North America as far south as Central America.

In Minnesota it is extremely local. It often becomes a familiar visitor in the door yards of country homes, flitting from tree to tree at dusk and taking its pay by constant and ill-timed forages upon the corn-cribs. Though very skillful the little animals sometimes overestimate their powers and falling short are precipitated to the earth, but their agility is so great that they are almost instantly in their place in the tree tops. When captured they make as engaging and sprightly pets as could be expected of nocturnal animals. To the nocturnal habit may be attributed the comparative constancy of the color pattern in spite of variation in other respects. The rodents which are exposed to diurnal conditions being, on the other hand, most variable in this particular.

The families are large and domestic, but little is known of the household economy.

GENUS TAMIAS, ILL.

"Skull narrowed anteriorly; post-orbital process long, very slender, directed downward and backward; plane of malar bone more oblique, and the zygomatic process of the maxillary more expanded and depressed than in *Sciurus*, but rather less so

than in *Spermophilus;* ante orbital foramen oval, situated in the base of the zygomatic process of the maxillary ; upper premolars two or one ; when two are present the first is generally minute ; ears of medium size or small, never tufted ; cheek pouches large ; pollex with a well-developed nail ; tail shorter than the body, flattened and rather broad, but shorter and narrower than in *Sciurus :* dorsal surface with two to four longitudinal whitish stripes, with a central and two marginal black stripes." This genus, though most closely allied to *Spermophilus*, links that genus very closely to the arboreal squirrels, to which some species bear a great resemblance in habits. The genus is apparently of North American origin, though one species is also found in Northern Asia and Europe. Dr. Merriam describes a new subspecies as *T. striatus lysteri*, upon a basis which it seems to us would make it possible to create endless named varieties of the more widely distributed species, especially if the seasonal and sexual and age variations are quite neglected. A new species is also described by Dr. Merriam, from California, as *T. microrhabdotes*.

Tamias striatus (Linn), Baird.

COMMON CHIPMUNK.

Length of body, 5.75 ; tail, to end of vertebræ, 3.65; to end of hairs, 4.25; fore foot, 0.80; hindfoot, 1.35. Middle of back, gray, rufous on the rump, grizzly brown to gray on head; sides yellowish, whole lower surface white; tail blackish above, hairs white-tipped. The back is ornamented by five narrow black stripes, the two lateral ones on each side being separated by white lines more or less buffy. A white superciliary line, and a yellowish stripe beneath the eye.

As bearing on the habits of this interesting and social rodent the following account is quoted from a sprightly article in the *American Naturalist* by Ira Sayles: (Am. Nat. vol. iv, p 249.)

"I lately noticed in my garden a bright-eyed chipmunk, *Tamias striatus*, advancing toward me. * * * Here he paused a moment and gave a sharp look all around him, as if to detect any lurking spy on his movements. (His distended cheeks revealed his business; he had been out foraging.) He now put his nose to the ground and, aiding this member with both fore paws, thrust his head and shoulders down through the dry leaves and soft muck, half burying himself in an instant.

At first I thought him after the bulb of an Erythronium that grew near * * * Presently, however, he became comparatively quiet. In this state he remained, possibly half a minute. He then commenced a vigorous action as if digging deeper; but I noticed that he did not get deeper; on the contrary, he was gradually backing out. I was surprised that in all his apparent hard work (he worked like a man on a wager) he threw back no dirt. But this vigorous labor could not last long. He was soon completely above ground, and then became manifest the object of his earnest work; he was refilling the hole he had made and repacking the dirt and leaves he had disturbed. Nor was he content with refilling and repacking the hole. With his two little hand-like feet he patted the surface, and so exactly replaced the leaves that, when he had completed his task, my eye could detect not the slightest difference between the surface he had so cunningly manipulated and that surrounding it. * * * It was now my turn to dig, in order to discover the little miser's treasure. I gently removed enough of the leaves and fine muck to expose his hoard—half a pint of buttercup seeds, *Ranunculus acris.* I took out a dozen seeds or so, recovered the treasure as well as my bungling hands could, and withdrew filled with astonishment at the exhibition of cunning, skill and instinct of the little much abused denizen of our field borders."

The chipmunk often appears during warm days in mid winter when it, in Minnesota, frequently feeds upon the bright berries of the bitter-sweet which can furnish but very little nourishment.

It is amusing to observe how fear often takes possession of these timid animals. When pursued by a dog they will take refuge in some low tree entirely secure from their enemy who at once pursues what seems the most preposterous method, barking and tearing the earth and going into a spasm of rage in the most insane fashion. It often proves effective notwithstanding, for, from sheer terror, the rodent springs wildly about until losing its foothold it falls into the very jaws of the dog.

Tamias asiaticus (Gmelin) Allen.

Var. quadrivittatus?

ROCKY MOUNTAIN CHIPMUNK.

PLATE IX, FIG. 21.

T. asiaticus is known to occur in the state from well authenticated skins collected by T. S. Roberts near Duluth and from observations made by Mr. Upham near Red Lake, indicating that the species ranges nearly entirely across the state to a considerable distance south of the boundary. The specimens of Mr. Roberts are not now before me, but several examples collected by myself in Canada, along the north-eastern shore of Lake Superior, probably are identical. Along the north shore this species is much more common than its larger rival and conforms with great satisfaction to the conditions of existence presented by the rocky soil and depauperated vegetation. It was never observed to climb, though carefully watched, where it was quite abundant and fearless. Several individuals visited our store-tent daily and gave us abundant opportunity to observe the activity and pert, pretty ways in whict it outdoes the familiar species.

The following table presents the available measurements, all being taken from animals collected at Michipicoten bay, Lake Superior, during July and August:

No.	Length of body.	Length of tail		Hind foot.	Fore foot.	Nose to eye.	Hight of ear.	
		To hairs.	To vertebræ					
1..	3.85	3.80	3.10	1.15	0.55	0.45	0 60	Fresh.
2..	4.00	4.30	....	1.25	0.61	0.54	..	Alcoh'l
3..	3.90	4.30	....	1.25	0.60	0.54	.....	Alcoh'l
4..	3.60	4.00	....	1.18	0.59	0.50	.....	Alcoh'l
5..	3.90	4.00	....	1.20	0.60	0.52	.....	Alcoh'l
6..	4.10	4.30	....	1.23	.....	0.53	.....	Skin.

These measurements are below the average of *T. quadrivittatus* but the bright coloration points in that direction.

The characters of var. *quadrivittatus* are given as follows: "Length of head and body, 4.50–5.00; of tail to end of vertebræ, about 3.50; to end of hairs, about 4.50. Pattern of coloration strictly the same as var. *borealis*, but the colors brighter, with much more rufous, and the size smaller. Under parts sometimes faintly tinged with fulvous. The black dorsal stripes are edged and more or less mixed with rufous; the light stripes, especially

the outer, are whiter, varying from grayish-white to pure white; the sides of body, especially anteriorly, are bright reddish ferruginous; the tail yellowish-rusty, with a sub terminal border of black edged with yellowish." The habitat assigned to this variety is the middle and southern portions of the Rocky mountains from near the northern boundary of the United States to New Mexico, westward to Pacific coast, eastward to the plains.

It is quite difficult to decide to which of the nominal varieties these specimens belong. They occur in the range of *borealis*, have the colors of *quadrivitattus* and size of *pallidus*. As a matter of fact, very likely these varieties do not express all of the tendencies to variation which seem to be governed by the actually existing conditions of life rather than to express the genetic relations.

The osteology of the Asiatic chipmunk would be of value only as taken together with a description of the entire anatomy and a minute comparison with other species of the genus, with a view to discover what relations exist between these closely allied species. A few measurements may prove instructive, as affording a means of comparison with *T. striatus*.

Skull—length, 1.25 (*T. striatus*, 1.60), width, 0.82 (0.97), nasals, 0.38 (0.51), incisors, to palate, 0.65 (0.85), between molars, 0.20 (0.24), rames, 0.80 (1.10).

Shoulderblade, 0.60 (0.80), humerus, 0.70 (0.90), ulna, 0.88 (1.00), longest metacarpal, 0.20 (0.28), pelvis, 0.85 (1.08), femur, 0.95 (1.10), tibia, 1.10 (1.21), longest metatarsal, 0.50 (0.54).

These figures indicate a much more slender skull in *T. striatus* (1.46—1.64 being the width to length ratios approximately). This is largely due to the greater facial prolongation of the latter, in which the nasal bone is contained 3.13 times in the length of the skull, while in the smaller species it is 3.28 times.

The humerus is shortest proportionally in *T. asiaticus* (1.35 and 1.22 being the proportions between humerus and femur in the two species.) Perhaps the shorter humerus may be correlated with less active and especially less arboreal habits. The *T. asiaticus* does not seem to burrow as extensively as our chipmunk. The greater length of the tail is as obvious in the skeleton as in the flesh.

Genus SPERMOPHILUS, F. Cuv.

This genus, a synopsis of which is given beyond, contains about twenty species confined to the northern continents of

both hemispheres. The spermophili are most numerous in the temperate and north temperate regions, and are essentially prairie animals. There are about equal numbers in America and the Asiatic-European continent. They are not found in the eastern portions of America; nor are they numerous in western Europe, so that the plains of Asia may be taken as their geographical centre. The fossil forms, of which there are several, do not afford conclusive evidence upon the origin of the genus. Its species are very like members of several different genera: *Sciurus* (the squirrels), *Tamias* (the chipmunks), *Cynomys* (the prairie dogs) and *Arctomys* (the woodchucks). Different species are more like one or the other of these groups, so the group is rather heterogeneous and consequently difficult to diagnose. The form is usually slender; the tail is not so bushy as in most squirrels, and its hairs are usually more obviously dichotomous in their arrangement than in squirrels. The tail is of variable length but, in the majority of cases, is short and stumpy. The ears are never tufted as in most squirrels, but may be quite large; in typical forms, however, they are small and rounded. Like *Tamias*, the gophers have well developed pockets opening inside the mouth and operated by special muscles. There may or may not be a nail upon the thumb.

Aside from these external characters there are some osteological peculiarities. There are always two premolars *i. e.*, five back teeth; the zygoma is flattened horizontally; the anteorbital foramen is triangular instead of a narrow slit and is protected by a spur at the lower outer corner.

The genus *Tamias* in habits and in structure forms the link between the gophers and squirrels, and the line of demarkation between the former is purely artificial. The genus has been divided into three sections or subgenera, and before passing to the list of species we may quote the diagnoses as revised by Allen, to whose paper in the Rodentia of North America the reader is referred for a full discussion of their position.

"Sub-genus OTOSPERMOPHILVS, Brandt. Ears large, high, pointed (larger and more pointed than in some species of *Sciurus*); tail long, full and broad, with the hairs two-thirds to three-fourths the length of the head and body; general form of the skull, and the dentition, strongly Sciurine.

Sub-genus COLOBOTIS, Brandt. Ears small, sometimes marginiform: tail short, flattened, with the hairs one-third to one-half the length of the body; skull short and broad, the zygomatic arches broad, generally greatly widened posteriorly; dentition heavy, and the first upper premolar generally large.

Sub-genus ICTIDOMYS, Allen. Ears generally small, sometimes rudimentary; tail long, cylindrical, or narrow and flattened, or quite broad, with the hairs one-half to three-fourths the length of the body; skull very long and narrow: first upper premolar usually rather small, and the dentition not heavy."

It will be seen that there are but two species, *S. franklini* and *S. tridecemlineatus*, whose range brings them within our limits, although specimens of one of the varieties of *S. richardsoni* might possibly cross our northwestern boundary. Both the species above mentioned may be found in suitable localities throughout the state. The *S. franklini* is less fossorial, and being a more conspicuous animal, is soon destroyed in thickly settled regions, while the great fertility and more subterranean habits of the leopard gopher, enable it to hold its own in spite of the best endeavors of the farmer and the army of boys and dogs who pursue it in the vicinity of towns. Their curiosity being the one failing which enables boys of exceptional patience to snare them at the openings of the burrows into which they have been seen to plunge.

Spermophilus tridecemlineatus MITCHILL.

PLATE X.

Sciurus tridecemlineatus MITCHILL, Med. Repos., xxi, 1821; DESMAREST, Mamm. ii, 1822.

Arctomys tridecemlineatus HARLAN, Fauna Amer., 1825; GODMAN, Am. Nat. Hist. ii, 1826.

Spermophilus tridecemlineatus AUDUBON and BACHMAN, Quad. N. A., i, 1849; HOY, Pat. Off. Rep. Agr., 1853; KENNICOTT, ib., 1856; BAIRD, Mam. N. A., 1857; THOMAS, Trans. Ill State Agr. Soc., 1860; ALLEN, Proc. Bost. Soc. Nat. Hist., 1870.

Spermophilus tridecem. var. *tridecemlineatus* ALLEN, Proc. Bost. Soc. Nat. Hist., 1874; Monographs N. A. Rodentia, 1877.

Arctomys hoodi SABINE, Trans. Linn. Soc., 1822; Franklin's Journal, 1823; FISCHER, Synop. Mam. 1829; WAGNER, Schreber's Säugethiere.

Arctomys (*Spermophilus*) *hoodi* RICHARDSON, Fauna Boreali-Amer., 1829.

Spermophilus hoodi F. CUVIER, Suppl. Buffon, 1831; MAXIMILLIAN, Reise N. Amer., 1839; Archiv. f. Naturgesch., 1861. WAGNER, Suppl. Schreber's Säuget., 1843; BRANDT, Bull. Physico-Math. Cl. Acad. St. Petersb., 1844; SCHINZ. Syn. Mam., 1845; GIEBEL, Säugethiere, 1855.

A full-grown female measures as follows: Head and body, 7.25; tail, 4.15; total length, 11.40; hind foot. 1.50; fore foot, 0.85; longest fore claw, 0.30; nose to eye, 0.80; nose to ear, 1.50; nose to occiput, 2.0; hight of ear, 0.30; longest hairs on the

tail, 1.0; lower incisors, 0.30; claw of thumb, 0.10; cheek pouches, 1.50 deep from incisor. The prevailing color is pale lemon yellow with almost a greenish tinge, this is everywhere warmed with suffusions of rusty orange so that at a distance the ground color might be called rusty yellow; about the lips, throat and eyes the color is nearly white; the upper part of the head is enlivened with bright orange anteriorly and chestnut with an admixture of dark brown posteriorly; the back is marked with about nine broad stripes of very dark brown locally suffused with chestnut, one of these stripes passing down the middle of the back beginning upon the occiput and fusing into the brighter colors on the upper surface of the tail; anteriorly this stripe is divided by a narrow band of the general body color, but back of the shoulders this breaks up into rather regular blotches occupying the middle of the dark band; the two dark bands on either side of the central one also contain rows of light spots, while the remainder of the dark bands are narrower and unspotted. The appearance thus produced is that of a dark dorsal surface broken by alternating continuous narrow, light-colored lines and rows of spots. The outer side of the hind legs is brindled and at the ankle there is a considerable suffusion of rufous. The tail is orange or chestnut with a bar of white near the end of the hairs, the longest of which are white tipped. The tail is scantily hairy and the hairs are dichotomously arranged. The posterior part of the sole is hairy. The vibrissæ are black and the longest reach to the ear. The ears are covered without and within with close fur. The muffle is very small. There is a pale depauperate variety (*pallidus* Allen) occupying the prairies of Colorado, Wyoming, and parts of Missouri and Arkansas. The species ranges from the Saskatchawan region to Texas and from Ohio to Utah. Minnesota is thus the peculiar home of the typical form and thus deserves the name "Gopher State."

Spermophilus franklini (Sabine) Lesson.

GRAY GOPHER.

Length, 9.50–10.50; tail to end of vertebræ, 5.50–6.50; to end of hairs, 6.50–8.50; nose to eye, 0.95; hind foot, 2.00.

General color brownish yellow above, pied everywhere by the black of the base of the hairs, which shows in wavy lines so as to produce almost a marbled appearance. The yellowish

fades out anteriorly, and on the head there is only pure black and white, mingled to form a clear grey, as also on the sides of the head. There is a conspicuous white ring about the eye, which is separated from the black of the lids by an inconspicuous yellowish line; a little yellowish too is found on the ears. The end of the nose is buffy. The sides of the body are lighter than the back, and the black is most conspicuous upon the sides of the hip and thigh. The outside of the fore leg is yellowish. The yellowish of the back extends some distance upon the tail, which, however, has a prevailingly whitish color, the hairs being yellowish white at the base, black medianly and for a considerable distance near the end pure white. The under parts, inside of legs and part of cheeks are white. Claws blackish, teeth white, iris dark brown. The pelage is stiff and nearly destitute of under fur, that of the tail being distichous and abundant, often nearly as full as in the gray squirrel, which this species not a little resembles. There are well developed cheek-pouches provided with special muscles. Six pairs of teats are present. The ears in this species are very small.

This graceful animal was at one time fairly abundant throughout the southern part of Minnesota, but is being rapidly exterminated by civilization. The natural home is about the edges of copses and it is not unusual for the animal to take refuge in a low tree or close thicket rather than its burrow. Being so much more conspicuous and less fossorial it is less fitted to hold its own than the striped gopher. It is still abundant about Big Stone lake, where it will approach the traveler's tent fearlessly and may be taken by the hand if desired. During the summer it feeds upon wild fruits, such as strawberries, but has well-marked carniverous propensities During a few days' encampment on Lake Traverse several of these animals became so domestic as to partake freely of fish from our table so long as no suspiciously hasty motions were executed by the human participants. The following are typical measurements for this region:

No. 86. (Female) Head and body, 9.75; tail to end of vertebræ, 5.50; to end of hairs, 6.70; nose to eye, 0 95; nose to ear, 1.80; hight of ear, 0.50; fore foot, 1.20; hind foot, 2.10; upper incisors, 0.25; lower incisors, 0.41.

In his monograph of the squirrels, Mr. Allen mentions that the gray gopher, *Spermophilus franklini*, was introduced in Tuckerton, New Jersey, in 1867; where it has gone on multiply-

ing ever since, as Mr. Jillson kindly informs me. Mr. Jillson writes under date of May 18th, 1885: "They are not numerous enough yet to do a great deal of damage to crops, but if a pair takes up its abode near small chickens or turkeys, they soon thin them out. When not frightened into their holes they generally plug them up with dirt, but always leave them open when out." This latter habit has not been noticed by any other observer, and is not shared in by the striped gopher; in fact it may be that this habit is one result of their more exposed habitat.

Genus ARCTOMYS, (Linn.) Schreber.

"Skull with the dorsal outline nearly straight; frontal region flat or depressed; postorbitals triangular at base, with a long decurved point; zygomatic arches moderately expanded, not widening and diverging posteriorly; grinding teeth rather small, the transverse and antero-posterior diameters about equal, and the molar series very nearly parallel; occipital and interparietal crests well developed; anteorbital foramina subtriangular, widest below, but not thrown outward.

"Size large; body thick-set, broad, depressed; cheek-pouches small; tail rather short, bushy not flattened; ears small; nail of pollex broad, flat, or wanting; pelage consisting of long coarse hairs and thick under fur. Coloration generally yellowish gray or brownish, without either distinct spots or stripes." The woodchucks are magnified *Spermophiles* with some of the characters intensified, but seem to be an older and more synthetic type—perhaps the most central living group of the *Sciuridæ*.

Three closely allied species are recognized from America, *A. monax* from the eastern United States north to Hudson's Bay, *A. flaviventer*, from the Rockies, *A. pruinosus*, from Alaska and northwestern America. The last is very close to the Old World form *A. marmota*, which is at home in the Alps, Pyrenees and Carpathians. A small species, *A. bobac*, occurs in Siberia and Russia.

Arctomys monax (Linn) Schreber.

WOODCHUCK.

Length, 13.50—15.50; tail to end of vertebræ 4.50; to end of hairs, 6.75; hind foot, 3.00; fore foot 2.30; nose to eye 1.50.

Color, a mixture of gray, fulvous and brown, below brown to rufous. Top of head, feet and tail dark brown to black; sides

of head and and throat yellowish, chin and nose gray. Below, especially about the fore legs, with much rusty red. Ears rounded, rather large. Tail short, bushy, terete. Colors vary greatly, with noticeable tendency to melanism. A patch of white marks the lower lip and a more or less distinct bar of gray crosses the muzzle. There is a curious callosity just above the short upper incisors. The sole has six callosities, the palm five. There are two pairs of pectoral and one of inguinal teats separated by an interval of five inches.

The woodchuck may be somewhat widely distributed in Minnesota but the only localities at which is has been encountered are upon the tributaries of the St. Louis and the shores of lake Superior. Here it does not appear to attain the size of the eastern specimens and perhaps is more brightly colored, though observations are lacking to support this statement. The habits are exactly those of the Spermophiles including the curiosity which makes them an easy prey to the trapper.

An adult Ohio female measures as follows: Length, 14.50; tail to end of hairs, 9.50; fore foot, 2.50; hind foot, 3.00; nose to eye, 1.80; nose to ear, 3.70; hight of ear, 1.00; width of muzzle, 1.15; distance between eyes, 1.90.

Family CASTORIDÆ.

This family is placed among the *Sciuromorpha*, thus expressing a relationship with the squirrels which is more completely seen in internal structure than in externals. The family differs from the squirrels in not possessing the postorbital frontal processes and in the oblique positions of the molar series. The teeth are imperfectly rooted and the enamel is folded, more as in the *Muridæ*. Some doubt may be expressed as to the correctness of this reference, since in several characters the resemblance is with the *Myomorpha*. The existing members of the *Castoridæ* are modified for aquatic life and seem to have descended from aquatic species.

The Myomorpha include several aquatic species but, beyond a superficial resemblance, even the muskrat has little in common with the beavers.

Beavers, not very unlike the existing species, made their appearance during the Miocene Tertiary. The genera *Trogonotherium* in India *Chalicomys* in Europe and *Steneofiber* and *Eucastor* in America were companions of their more favored relative. The Miocene was the period during which the rodents differentiated

most rapidly, leaving little but retrenchment for the following periods.

Eucastor was a genus of small beavers the known examples of which were less than half the size of our species. There is some reason to doubt if it is more than sub-generically distinct from the modern form.

Steneofiber and *Palæocastor* are vicarious genera, the one in Europe the other in America, which may easily be identical.

Trogonotherium contained species considerably larger than existing beavers.

Genus CASTOR.

Feet five-toed, hind feet palmate; body stout, especially behind; tail laterally expanded, scaly; skull somewhat as in squirrels but without postorbital frontal processes. Molars $\frac{4-4}{4-4}$, single rooted, the dentinal pulp persisting until a late period, triturating surface composed of enamel folds; lower jaw massive, symphysis firmly closed. The genus is represented at present by a single circumpolar species which may be divided into two sub-species or varieties with very close relations.

The very careful review of the evidence bearing on the question of the relation of the two forms given in Dr. Ely's account contained in Morgan's "Beaver and His Works", makes a discussion of the matter unnecessary. Certain constant but minute differences in osteology and the nature of the secretion are demonstrated, while the importance to be admitted for them must be a matter of opinion.

Castor fiber Linn.

BEAVER.

Body thick and heavy, with the greatest diameter near the hips, length about 30 inches; tail, 10 inches; the head is broad, depressed; nostrils lateral in a naked muffle; ears nearly hidden in the fur, rounded; the fore feet are small and are not used in swimming; hind feet broad, webbed, second toe often with a double claw; color, reddish-brown, darker in winter. The long hairs are coarse and glossy, the under pelage soft, fluffy and of a grayish color. Melanism is common northward, albinoes not being rare. The beaver is the largest North American rodent; indeed, with the single exception of the capybara, it is the

largest living species, and but few fossil forms could have much excelled it, the gigantic *Casteroides*, elsewhere mentioned, being perhaps the largest as it was nearly the size of a black bear. A detailed account of the anatomy of the animal is given in Capt. Morgan's work already referred to, to which the reader is referred.

The natural history of the beaver makes a pleasing chapter in science both on account of the charming social habits of the animal and the intelligence indicated by his architectural powers. The beaver is *par excellence* the builder among our native animals and the forethought evidenced by the dams and other structures compels interest.

With the teeth for ax and chisel and the tail as trowel, the beaver is able to perform feats of mechanical engineering worthy of human tools and ingenuity. The fore feet, although small and useless in swimming, are dexterously employed in building, there being considerable play between the bones of the fore arm. The claws are strong and and adapted to burrowing as the animal is regularly fossorial. The hind feet are fully webbed and the claw of the second toe has a curious projection below peculiar to this animal. The hearing and smell are acute and in part compensate for rather imperfect sight. Although social, the social instinct extends but little beyond the family circle and is by no means so extended as often imagined.

From two to six young are born after a period of gestation of about three or four months. The young are born in May and may be weaned in six or eight weeks.

The food of the beaver consists almost entirely of the bark and wood of deciduous trees, birch, cottonwood, willow, poplar and maple being preferred. In order to obtain the green nutritious bark of the branches, trees of astonishing size, considering the implement used, are cut down and dismembered.

In preparing for winter great industry is shown. As the beaver does not hibernate, he requires suitable food laid away for four months of enforced confinement. Like the pocket gophers, they are equal to the emergency. Commencing in September they cut and store their winter's food. Though this labor is performed chiefly at night, beavers are not strictly nocturnal. In regions where they have been unmolested they swim freely by day and sun themselves like the muskrat.

The location of the burrow and the building of the lodges indicate great skill, judgment or instinct.

The beaver is naturally pre-emminently a burrowing animal and the lodge is thought to have been derived from a modification of the burrow. Where the burrows have been broken into by accident they are frequently repaired with sticks and grass, thus imitating a lodge and perhaps suggesting how the latter may have originated.

The burrow is the city of refuge and is always provided although the family occupies a lodge. The entrance to these burrows is usually from beneath the roots of a tree and the adit may be ten or fifteen feet long. The chamber in which it terminates is perhaps two feet in diameter. The end of the burrow is often protected by a pile of sticks which serves in winter to prevent the solidification of snow over the chamber and thus excluding the air. Such heaps of sticks may have been the introductory step to the formation of the lodge. In many regions where beavers are abundant lodges are not found. The European variety does not exhibit the architectural skill for which ours is noted.

The lodge seems to be adapted for a brood chamber, and varies with its location. It is a dome-shaped structure composed of poles and earth. The lodge is small at first, and is not abandoned at the end of the season, as in the case of the muskrat, but is enlarged annually. The cavity within, which usually communicates with the exterior by two openings, is gradually enlarged, and the lodge receives increments of sticks from without. The sticks laid up for winter are used in the spring for repairing the lodge and the dam. Each fall the lodge is plastered externally with mud, which freezing makes it very firm. A large lodge may measure over twenty feet in external diameter, and the chamber corresponding, eight feet, and a foot and one-half in hight. The floor of the chamber is usually near the water's edge, and is beaten hard. The skill displayed in the construction of a lodge is no greater than that of the muskrat; the superiority of the beaver lies in his skill in constructing dams and other structures secondary to the lodge. Canals and dams constitute the *chef d'ouvre* of the beaver. The dam precedes the lodge in the order of formation, and is designed to retain the water in the pond selected as the site of the lodge at a constant level. The dam, like the lodge, is of gradual formation, and is not necessarily the product of co-operative industry beyond the limits of a single family. Dams are either permeable or compact. The solid dam is preferred where the opening is well defined and furnished with

firm banks. The dam is begun by laying sticks in regular order parallel to the current and loading with rocks and mud. Nothing of the nature of stakes or piles is employed. The poles may be twelve feet long, and are arranged with great precision. The inner slope is more abrupt, and is faced with earth and turf, forming below an impervious layer. The dam requires constant repairing, and may be added to annually until it becomes a very considerable and solid structure. The upper part of the dam being more permeable than the lower, the water is permitted to percolate through without gathering head at any place, thus preventing injury. The best authorities state that there is no co-operation in the work of repairing, but that each beaver examines and builds as he sees fit. Others claim that there is a systematic supervision by older members of the clan and appointed relays, reserves and the like. This may be due to the close concert of action observed. When busily engaged upon their structures, carrying earth and troweling it upon the inside of the dam, or patting it firmly on the lodges with their tails, the appearance is very like that of a disciplined force of builders, and at the approach of danger, the simultaneous disappearance of the party, each with a distinct slap upon the water with the tail, tends to highten the effect of concerted action.

The beaver not only forms dams and lodges, but excavates extensive canals through the swampy ground adjacent in order to transport the cuttings and boughs used in construction. Often the trees used by the beaver are not found in immediate proximity to the pond, and such canals are carried to the higher ground where suitable growths of poplar, birch or maple are situated. The boughs used upon the dam are often so large as to be carried with great difficulty on land, but can be transported by water with ease. Such canals also connect the pond with the burrow where the margins are soft and swampy. Canals of this sort are often over 100 feet long. Where the banks are abrupt the beaver excavates inclined passages or slides, somewhat similar to otter slides, along which the brushwood is carried to the stream. This reminds one of what may be seen along the white cliffs in the Tyrol, where well-worn slides several hundred feet long mark the ways along which peasants send the faggots used for fuel in the valleys.

When abundant, the beaver is easily trapped, and its fur was once a staple commodity among the early settlers, often taking the place of currency. The trap, which is a medium-sized

double-spring steel, smoothed-jawed trap, is placed in a breech in the dam and is intended to catch the unconscious repairer by the hind foot, as the fore foot would be torn away or severed by the teeth. Traps are also frequently set at the opening of the lodges or burrows, or even in frequented run-ways. The usual practice is, where possible to arrange the ring at the end of the chain so that it will slide downward upon an obliquely placed pole and drown the beaver, which instinctively dives when first discovering its peril.

Sometimes gum camphor, castoreum or oil of juniper is used to attract beaver to the vicinity of the trap. A more destructive method is sometimes employed. A party systematically drives the beaver from the lodges to the burrows, the mouths of which are then stopped, and the beaver are dug out and easily secured. The Indian resorts to a method requiring more patience and cunning. The pile of twigs gathered for food is barricaded, only a single opening being left. This is guarded by a twig, the movement of which apprizes the watcher of the entrance of the unsuspecting animal into the enclosure, which is now closed, and the beaver being confined under the ice soon drowns and is removed to make room for another victim. A single trapper can care for a line of thirty or forty miles.

The beaver has been generally distributed over the wooded parts of the United States. The following quotation from Geikie's Geological Sketches will illustrate the conditions in many other regions: "The extent to which the valley bottoms in this and the other mountain ranges of western North America have been changed by the operations of this animal is almost incredible. In a single valley, for example, hundreds of acres are gradually submerged and their cottonwood or other tree-growth is killed. In this way the floor of the valley is cleared of timber. The beaver ponds, eventually silting up, become first marshes and then, by degrees, fine meadows."

In most of the wooded parts of Minnesota beaver were once abundant, but the traces of their existence are rapidly disappearing, and lodges can now be found only in the inaccessible regions far northward.

Family MURIDÆ.

The North American *Muridæ*, according to Dr. Coues, may be characterized as follows:

Dental formula: i. $\frac{1}{1}:\frac{1}{1}$. c. $\frac{0}{0}:\frac{0}{0}$ pm. $\frac{0}{0}:\frac{0}{0}$ m. $\frac{3}{3}:\frac{3}{3}$. Anteorbital foramen a large pyriform slit, bounded anteriorly by a broad

plate of the maxillary. Coronoid, condylar, and descending processes of the mandible well developed and distinct. Tibia and fibula united below. Two sub-families *Murinæ* and *Arvicolinæ* are here recognized.

SUBFAMILY MURINÆ.

This subfamily contains a large number of sprightly animals, represented very familiarly by the domestic pests, and easily distinguishable from the field mice, which constitute the other subfamily of the *Muridæ*, by their slender, lithe form, large eyes and ears, pointed snout, and the long tail, which is covered with circlets of scales.

In this subfamily the teeth are rather adapted to an omnivorous diet than a strictly herbivorous or gramnivorous one. The incisors are rather narrow, squirrel-like, and the molars are rooted and with tuberculate crowns. The skull is quite different from that of arvicoline rodents. The nasal bones project forward. The zygomas are abruptly curved downward, the palate is simple, and the angle of the mandible not strongly hamular.

Instead of going into elaborate details it is thought better to reproduce the admirable tabular statement drawn up by Dr. Coues and published in Monographs of North American Rodentia, p. 45.

NORTH AMERICA.	SOUTH AMERICA.
a. *With grooved upper incisors.*	
Genus OCHETODON, Coues. Form murine.	Genus REITHRODON, Waterh. Form leporine.
b. *With smooth upper incisors.*	
Subgenus VESPERIMUS, Coues. Form murine.	Subgenus CALOMYS, Waterh. Form murine.
Subgenus ONYCHOMYS, Baird. Form arvicoline.	Subgenus HABROTHRIX, Waterh. Form arvicoline.
—— ——?	Subgenus OXYMICTERUS, Waterh.
Subgenus ORYZOMYS, Baird. Form rat-like.	—— ——?
Genus HOLOCHILUS, Brandt. Form rat-like.	Genus SIGMODON, Say. Form arvicoline.
—— ——?	Genus NEOTOMA, Say. Form rat-like.

Genus VESPERIMUS, Coues.

A word of explanation is necessary in thus employing the name usually considered subgeneric under *Hesperomys* as of full generic value. This change was the result of an attempt to diagnose the genus *Hesperomys* as it now stands in our literature, with the groups *Vesperimus*, *Onychomys*, *Oryzomys*, *Calomys*, *Habrothrix* and *Oxymicterus* as subgenera. It was found impossible to distinguish these genera collectively from the associated genera by any characters of a higher sort than those separating them among themselves. In this dilemma the simplest remedy seemed to be to disregard altogether the generic name *Hesperomys*, which was, as pointed out by Baird, orginally applied to the whole group of *Sigmodont Muridæ*. Moreover, *Hesperomys* would need to give place to the prior name, *Sigmodon*, if its signification were simply restricted to the whole group to which it could naturally be applied. *Sigmodon*, however, is duly recognized as a valid generic term, and for our part we do not see that any harm can result from the change proposed.

The genus *Vesperimus* was amply characterized by its founder and, as by him diagnosed, includes animals of medium or small size, lithe form and quick movement. The long hind legs and rather short anterior extremities adapt them for rapid running and springing, while the short fore claws indicate that they are not fossorial. The fore feet are rather less than half as long as the six tubercled soles. The palms are naked, while the soles, in most of the species, are furry posteriorly. The tail is usually long as compared to other native mice, ranging from considerably longer than the remainder of the body to the length of the trunk alone.

The head presents an animated appearance. The bright prominent eyes, large sparsely pilous ears and acute muzzle conspiring to give vivacity to the face. The ears are unusually large and thin. The colors are bright, and the contrast between the upper and lower surfaces of both body and tail is marked.

The most unreflecting person would be forced to admire the sprightly deer mice, and they universally attract attention, while their inroads upon the graneries are rarely so great as to merit the execration poured upon their domestic cousins.

The cranial and other anatomical characters may be gathered from the specific description beyond ; a few points only need be noticed. Characteristic features are the slender rostral part occasioned by development of the nasals and premaxillaries, the broad, low, cranial portion, and deflected zygomas.

The lower jaw is elongated, with low coronoid and broad but not hamular angle. The skull is twice as long as wide. The length of the lower jaw is about three times its hight.

The scapula differs from that bone in *Arvicola* by being less slender and having a short acromium and broad metacromium. The deltoid ridge of the humerus is fairly developed. The sternum consists of six sternebræ, the manubrium being very broad anteriorly. The fibula is united with the tibia, as in *Arvicola*, but is less slender, and the limb is proportionally longer.

We have purposely omitted the dentition from the above account, preferring to quote Coues' statements as the most satisfactory general account at hand:

"The molar series is both short and narrow, between one-sixth and one-seventh the length of the skull. . . . The molars rapidly decrease in size from before backward, particularly in the upper jaw, where the last one is subcircular, and not more than half as large as the middle one, which itself is less than the front one. . . . The molars of the upper jaw have three roots apiece, two external and one internal; those of the under jaw have but two, placed one after the other on the median line. . . . The unworn molars of *Hesperomys* show a double lengthwise series of conical tubercles connected by lower crosswise ridges, and the whole face of the tooth is encased in a sheet of enamel continuous with that of the sides of the tooth. . . . The tubercles are not exactly opposite each other in crosswise pairs, but are half-alternating. Down between the bases of these conical eminences are seen furrows, the more readily noticeable because generally blackened, apparently by the sticking of foreign matter in them. They represent the deep, close-curved plications of enamel that penetrate the tooth from either side, the ends of the loops nearly or quite meeting in the substance of the tooth. . . . It will be seen that, after abrasion has commenced, the molar crowns will present a different pattern with each stage of the process. . . . The student may imagine the top of a pigeon pie, full of humps and hollows, gradually razeed down by a succession of thin parallel horizontal slices. Let the crust be the enamel, and the substance of the pie the dentine; the first slice will shave off the tops of one or more humps, exposing the interior (dentine) in isolated places, these islands lying in a network of crust (enamel)."

The habits seem to be as uniform as the structure, and our species may furnish an idea of the group.

Vesperimus leucopus RAFINESQUE.

WHITE-FOOTED OR DEER MOUSE.

PLATE XI.

Mus sylvaticus var., ERXLEBEN, Syst. An., 1775.
Mus sylvaticus var. *noveboracensis* FISCHER, Synopsis, 1829.
Mus noveboracensis SELYS-LONGCHAMPS, Etudes de microm., 1839.
Mus agrarius var. *americanus*, KERR's Linnaeus, 1792.
Mus agrarius GODMAN, Am. Nat. Hist., 1860.
Musculus leucopus RAFINESQUE, Am. Monthly Mag., 1818.
Mus leucopus DESMAREST, Mam., 1822.
HARLAN, Fauna Amer., 1825.
GRIFFITH, Animal Kingd., 1827.
FISCHER, Synopsis, 1829.
RICHARDSON, Fauna Bor. Am., 1829.
DEKAY, N. Y. Zool., 1842.
AUD. & BACH., Quad. N. Am., 1849.
THOMPSON, Nat. Hist. Vermont, 1853.
KENNICOTT, Agri. Rep. U. S. Pat. Office, 1856.
Hesperomys leucopus LECONTE, Proc. Acad. Nat. Sci. Phila., 1852.
BAIRD, Mammals of N. A., 1857.
ALLEN, Bull. Mus. Comp. Zool., 1869, 1870.
DALL, Alaska and its Resources, 1870.
MAXIMILIAN, Arch. Naturgesch., 1862; Verzei. N. Am. Säugeth., 1862.
Hesperomys (*Calomys*) *leucopus* WAGNER, Schreber's Säug.
GIEBEL, Die Säugethiere, 1859.
Hesperomys (*Vesperimus*)*leucopus* COUES, Proc. Acad. Nat. Sci. Phila.,1874; Monogr. North Amer. Rod., 1877.
Hesperomys (*Vesperimus*) *americanus* COUES & YARROW, Rep.Zool. Expl. W. 100 Merid., 1875.
Cricetus myoides GAPPER, Zool. Journ., 1830.
Hesperomys myoides BAIRD, Mam. N. A., 1857.
Arvicola emmonsi DEKAY, Rep. Quadrupeds Mass., 1840.
Hesperomys maniculatus WAGNER, Wiegmann's Archiv., 1843-1845; Abhand. Akad. Wiss., 1848.
Hesperomys polionotus WAGNER, Wiegmann's Archiv., 1843.
Hesperomys campestris LECONTE, Proc., Acad. Nat. Sci. Phila., 1853.
AUD. & BACH., Quad. N. A., 1854.
BAIRD, Mammals N. A., 1857.
Hesperomys texanus WOODHOUSE, Proc. Acad., Nat. Sci. Phila., 1853; Sitgreaves' Rep. Expl. Zuñi R., 1853.
AUD. & BACH., Quad. N. A., 1854.
BAIRD, Mam. N. A.,1857; U. S. & Mex. Bound. Surv.,1859.
KENNERLY, Pac. R. R. Rep., 1859.
Hesperomys cognatus LECONTE, Proc. Acad. Nat. Sci. Phila., 1855.
BAIRD, Mam. N. A., 1857.
Hesperomys gracilis LECONTE, Proc. Acad. Nat. Sci. Phila., 1855.

Hesperomys austerus BAIRD, Proc. Acad. Nat. Sci. Phila., 1855; Mam. N. Amer., 1857.
COOPER & SUCKLEY, Nat. Hist. Wash. Ter., 1860.
Hesperomys boylii BAIRD, Proc. Acad. Nat. Sci. Phila., 1855, Mam. N. A., 1857.
Hesperomys gambeli BAIRD, Mam. N. A., 1857; Pac. R. R. Rep., 1859.
NEWBERRY, P. R. R. Rep., 1857.
COOPER & SUCKLEY, Nat. Hist. Wash. Ter., 1860.

The white-footed or deer mouse is familiar to every farmer's boy, and claims admiration, not only on account of its graceful form and spirited appearance, but by its pretty though subdued coloration and sprightly movements. The soft brown pelage of the upper parts contrasts nicely with the pure white of the feet and under parts. The origin of the name deer mouse is found partly in the fawn color which is the normal color of the back and partly also in the long leaps by which the mouse escapes its pursuers. In the young the shade is less bright and is more like that of the house mouse, while the dorsal colora tion extends downward on the outside of the legs. That the animal is subject to interminable variations in color is seen from the long list of synonyms given. A full discussion of the value of specific characters based on such varieties of coloration may be found in Coues' article on this species in the monographs of N. A. Rodentia, already frequently referred to. It may be admitted without discussion that the specific identity of the names united above is settled once for all by that author's careful revision. Our Minnesota specimens, when adult, are remarkably uniform, and present no noteworthy variations. The upper parts are a warm brown as far as well down upon the shoulder and hips. The back is considerably darkened by numerous nearly black hairs while the tail is dark brown above and pure white below. The thighs are gray. The ears are dark with a white margin. There is a dark spot at the base of the whiskers which are themselves black. The size of this species varies somewhat, but the chief differences are in the proportional length of tail and body.

For Minnesota the following measurements are typical for the female:

Total length 7.0; tail 3.4; body 3.6; hind foot 0.9; fore foot 0.4; span of hind legs 4.4; of fore legs 3.4; nose to eye 0.55; nose to ear 1.0; hight of ear 0.7.

The length of the male is less by half an inch than in the female, the proportions remaining about the same.

According to Coues the averages of eighty specimens from Massachusetts are as follows:

Total length 6.45; trunk 3.25; tail 3.20; nose to eye 0 50; nose to ear 0.90; palms 0.34; soles 0.80; ears 0.55.

It must be remembered that measurements of prepared specimens in which age and sex are, for great part, neglected, are eminently untrustworthy. Could such sources of error be eliminated probably much of the variability assumed would disappear. Although, therefore, the size of Minnesota specimens seems slightly to exceed the average of the eastern form, there is no certainty of this, our measurements giving the full *normal* size. On the other hand the length of the tail and the size fully distinguish our deer mice from the Arctic variety which is characterized by a shorter tail and larger size. The size is about as in the nominal variety "*myoides*," but the tail is not generally as long as the head and body. Our specimens may be unhesitatingly compared with those from northern New England. Students of these animals should be warned that the length even of the tail and feet, particularly the former, changes considerably in drying, hence. only fresh measurements are of positive value in a critical discussion. As we have but three quite distinct forms of the numerous styles of *Vesperimus* in Minnesota we are happily not required to meddle with such matters.

"It [the white-footed mouse] is a good climber, and I have often found its nest in holes in living trees, more than seventy feet above the ground. While on a snow-shoe walk with a friend one bright moonlight evening, several winters ago, one of them was observed skipping lightly over the snow a short distance ahead. We gave chase, but the mouse escaped by running up the trunk of a smooth-barked beech hard by. My friend, who was not aware of its climbing propensities, looked on in amazement while the mouse, with as much ease and nimbleness as a squirrel, ascended the tree and disappeared in a knot-hole high among the branches.

"The white-footed mouse does not hibernate. Except during the severest weather, its tracks may be seen on the snow throughout the winter, its long tail leaving a furrow by which it may always be recognized. In the autumn it lays up an immense store of provisions for so small an animal[1]."

In forest regions beech-nuts are said to usually furnish the winter larder and it is not rare to find several quarts thus stored away. Kennicott speaks of having found within a

(1). Mammals of the Adirondacks, p. 263.

stump in a clover field, several quarts of clean red clover seed collected by a family of these mice.

Dr. Samuel Lockwood in the "American Naturalist" for 1871 contributes a delightful chapter on the musical capacities of the wood mice. This we quote almost entire as placing the animal before us in vivid and novel light and applying almost as well to the present species.

"Last spring my friend, Philip Ryall, Esq., brought from Florida a mouse which he had captured in his residence there. He says that for a number of nights a low sound of a more or less musical nature had been heard proceeding, as was supposed, from the chimney, and which was very naturally attributed to the chimney swallow. One day a small mouse came from under the hearth into the middle of the floor of the sitting-room, sat up and sang for about a minute and retired. This explained the mystery. Its nightly music and its daily visit were continued, almost invariably, the visit being limited to the same small area of the floor. It was determined to capture the little stranger, which, after many unsuccessful attempts, was finally accomplished. Last June the interesting little fellow was very kindly passed into my custody. My first concern was to add to its comfort by enlarging its cage, also to provide in every possible way a condition of things suited to its nature. For all this I was amply rewarded in the fine health and the musical performances that followed.

"A little study soon determined that the pretty creature belonged to the Vesper mice. It is known by the popular names of Jumping mouse, Wood mouse and White-footed mouse. Our specimen is one of the smallest of its own genus, for the precise species is the one known to naturalists as *Hesperomys cognatus* Leconte. This fact, so novel, once determined gave additional zest to my purpose to make it an object of especial study. To give it individuality, as it was fast becoming a pet, I named it Hespie, which name, as its object was female, was certainly appropriate. I thought she soon learned to know me, and certainly I soon came to regard her with attachment. Yet, the truth told, she was a pretty, pert and unamiable little miss, and would permit no familiarity, always biting the finger that attempted to touch her. Her animation, agility and gracefulness of motion were wonderful. Sometimes a fly would enter the cage, when she would spring at and catch it, sometimes with her mouth and at others with her hands. This she would eat with great relish. So uniformly quick were her motions,

that on one occasion my little boy said: 'Papa, I would like to see mousie *walk* just once.' Her taste was quite omnivorous, although, unlike the domestic mouse, she did not care for cheese. But meat, corn, nuts, sugar and even pudding and fish were all acceptable. A little sod of fresh grass and white clover was occasionally put into the cage. This she enjoyed greatly, eating the greens like a rabbit; only always insisting on sitting up to it. It was interesting to witness how ready she was for emergencies. Sitting on her hind feet, she would take hold, with her hands, of a blade of grass and begin eating at the tip. The spear would rapidly shorten, and seemingly she must now stoop to finish it, or do it in the ordinary quadrupedal style. Now, that was just what she did not choose to do. So, when the emergency came, she would stoop down and in a trice cut the blade off close to the sod with just one nip, then up again on her feet in a sitting posture, she would finish it in a comfortable and becoming way. On one occasion a worm crept out of the sod and Hespy at once fell to it and soon had it tucked away without cooking. As to exercise, she manages to take a great deal. In the day time her exercise is less, as she does a good deal of sleeping then. It is at night that her peculiar talents appear to advantage, beginning at vespers, as her name might imply. Then, as a singer, her genius literally shines. It is with her singing that we are most concerned, and indeed, at the moment of this writing (for it is night) she is in fine song. Perhaps, however, it will seem more literal and actual if her performances are described in the past tense.

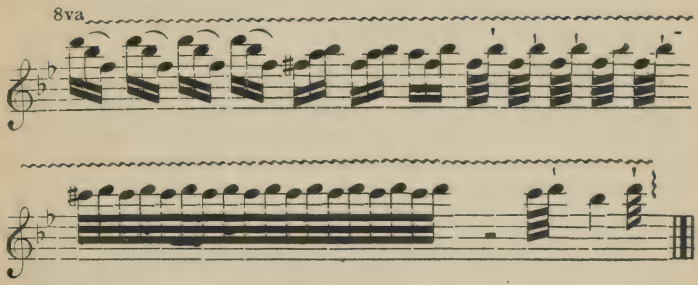
"Our little musician had several snatches or bits of melody which were often repeated. But in her *repertoire* were two notable ones, each of which deserves to be dignified as a professional *role*. The one by far the more frequent is noted below, and because it is her favorite, when running in her revolving cage, it was named '*The Wheel Song*.'*

"The last bar of this would frequently be prolonged to two or three, and she would sometimes change from *c* sharp to *d*, to *c* natural and *d*, then warble on these two notes awhile and wind up with a quick chirp on *c* sharp and *d*. The distinctions between the semi-tones was very marked and easily appreciable to a good ear. I have always enjoyed the mellow little strains of the song of the sparrow and the house wren. But in either case it was short and apt to become monotonous from its admitting almost no variation. Monotony was not chargeable to

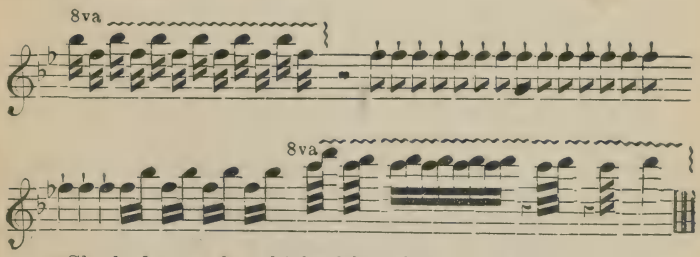
* The musical notation was written by my son, Ferris C. Lockwood.

Hespie's Wheel Song. With unconscious skill she would work it out in wonderful variety. Instead of the first measure, she would sometimes open with the second one and then follow it with the first. Or she might start with the third, following with the second or first, just as fancy seemed to dictate. Then she had her whims as to the amount of repetition of each bar, that is to say, she would double or even triplicate a measure when the notion tock her. In this regard time was quite ignored. Indeed, whatever may have been the *Hesperomys'* canon of musical procedure or propriety, we could not but regard it as arbitrary, or beyond our comprehension. Still, it must be admitted that this litile performer possessed precission, delicacy and scope of excution.

NO. 1. THE WHEEL SONG.



NO. 2. THE GRAND ROLE.



"She had one role, which although the notation is simpler than that of the Wheel Song, yet I think, to her, its execution was more difficult. It is certain that she was far more chary of its performance, and to me its effect seemed more impressive. I have, on account of its infrequency, distinguished it as '*The Grand Role.*'

"This was seldom given, yet quite often enough to allow it to be written down on board. The second measure would be sung quite fast, sounding almost like the pecking of a woodpecker on a tree, and at other times it would be slow like the dropping of water. Although she had no ear for time, yet she would keep to the key of *b* (two flats), and strictly in a major key. This fact I consider interesting, as Wood declares his belief 'that the untaught cries of all the lower animals, whether quadrupeds or birds, are in the minor key.' Herein theory must yield to observation. If I might venture an opinion, it would be that the music of the really musical wild animals is oftener on a major key, while the minor key characterizes savage man. A remarkable fact in the above *role* is the scope of little Hespie's musical powers. Her soft, clear voice falls an octave with all the precision possible; then, at the wind-up, it rises again into a quick trill on *c* sharp and *d*.

"Though it be at the risk of taxing belief yet I must, in duty, record one of Hespie's most remarkable performances. She was gamboling in the large compartment of her cage, in a mood indicating intense animal enjoyment, having awoke from a long sleep, and partaken of some favorite food. She burst into a fullness of song very rich in its variety. While running and jumping, she rolled off what I have called her Grand Role; then sitting, she went over it again, ringing out the strangest diversity of changes, by an almost whimsical transposition of the bars; then, without for an instant stopping the music, she leapt into the wheel, started it revolving at its highest speed, and went through the wheel song in exquisite style, giving several repetitions of it. After this she returned to the large compartment, took up again the Grand Role, and put into it some variations of execution which astonished me. One measure, I remember, was so silvery and soft that I said to a lady who was listening, that a canary able to execute that would be worth a hundred dollars. (I occasionally detected what I am unable to explain, a literal dual sound, very like a boy whistling as he draws a stick along the pickets of a fence.) So the music went on, as I listened, watch in hand, until actually *nine minutes had elapsed*. Now the wonderful fact is, that the rest between the roles was never more than a second of time, and during all the singing, the muscles could be seen in vigorous action through the entire length of the abdomen. This feat would be impossible to a professional singer, and the nearest to it that I have seen was the singing of a bird in the grove.

"For several days the wheel grated on its axle. This afforded Hespie great delight, and her own little warble was completely lost in the harsher sound. It was pretty much as it is with some of the modern methods of praise, as when the vocal is subordinated to the instrumental, a mere murmur of song, on which the organist comes down as with the sound of many waters. A drop of oil, and the sound of the friction stopped. This quite excited her temper, and she bit at the wires of her wheel most viciously. A little device was hit upon which set her in good humor again. A strip of stout writing paper, half an inch wide, was pinned down in such a way that its clean-cut upper edge pressed against the wires of the wheel, making with its revolution a pleasant purring sound. It was on the principle of the old-time watchman's rattle, and the old toy known as a cricket.

"This for a while greatly delighted the capricious creature, and she made the wheel almost fly; at the same time, in unison with the whirr of the wheel, was her own soft, cheery warble. It was very low, yet very distinct. I remember once on a larger scale witnessing an analogous sight, when, unseen, I entered a room in which was a woman spinning wool, and singing at the top of her voice, in keeping with the loud whirring of the spinning wheel. Without her wheel the domestic life of little Hespie would be rather monotonous. * * * We next shut her out of the wheel by corking up the entrance. She worked desperately at the closed aperture; then in despair gave vent to a piercing little cry. It was surprizing what a strange pleasure this sound afforded me, it showed so clearly the difference in the timbre or quality of the sound of distress from that which I have called its singing. She was a good deal excited, and ran frantically into and out of her little bed-box, which had a hole at each end. Soon this tiny gust of rage passed over. She now, though running about her cage, indulging in little gambols, indicating grace and agility, struck off into a truly beautiful strain of song. It occupied about three minutes, and had in it considerable scope and variety. First, there was a clearly enunciated expression like that of the cooing of a turtle dove, a soft note with a deliberate slowness. This changed into a series of more rapid notes strangely suggesting the not so weird-like, the conchy clamor of the American cuckoo (*Coccyzus*), then closing with a series of short, rapid sounds like the tapping of a woodpecker on a tree." "A very noticeable fact was, that a great deal of this little creature's

song was poured forth while at play, that is, while in actual activity; and, take the wheel-play, for instance, when really in quite violent exercise. A thing, too, which much surprised me, was, that often when eating she sang and ate at the same-time, literally in the same breath. This singular habit, so suggestive of a great physiological difficulty, led to an incident, which caused considerable merriment for those who witnessed it. I had been examining some insect larvæ on a twig of black alder. Without any real motive, a bit of the twig, about an inch long, and an eighth of an inch thick, was offered Hespie. She was delighted, and at once began in her usual pretty way, sitting up, to eat the bark, although it is very bitter. Thus she sat "bolt upright;" and the manner in which she held this little black stick in both her hands up to her mouth, at the precise angle at whith a fife is held, although nibbling away, yet singing at the same time, it looked so like a little fifer playing on an ebony fife that laughter was irresistible at the comical sight."

"Wishing to see how this Hesperomys would behave in company, I put into her cage a young domestic mouse about one-third grown. She was asleep in her little box. When she awoke it was a pretty sight. What animation! How the black eyes started and sparkled! To me they seemed to snap with fire. The whole frame was in a quiver—first of astonishment, then with rage. It was not a run—but a jump which she made at the little involuntary intruder, who received a nip that made it squeal in terror. We removed the little captive, who was so astonished that it was quite content to lie in our hand. Its terror had won our pity, and we restored to it its liberty." * * * "And now we ask are these phenomena that have been herein described the result of an abnormal condition of things or not? How much truth is there in the theory of some that the singing of these mice is the result of disease, or of some bronchial disturbance? In my opinion the following reasons disprove the truth of any such theory:

1. The exquisite animal enjoyment and actual physical condition, for it is fat and perfect in pelage and form, indicating high health. Every form of bronchial disease is, in its most ordinary effect, depressing to the animal spirits.

2. When engaged in song, the exercise reaches to the very depth of the chest, as is so often seen in the lowing of kine, where the muscles may be observed in action for the whole length of the abdomen. Persons afflicted bronchially avoid deep vocal exercise.

3. The singing is so often performed under those precise circumstances in which bronchially diseased persons are sure to keep still, if possible. For instance, take the Wheel Song. Here, although the exercise was violent, yet the song would be sustained with no diminution of vocal strength; and quite frequently was it the case, that when the animal stopped turning the wheel, though it continued the song, the momentum would throw it on its back, when as if in surprise, it would roll off four or five notes on a higher octave, and in a greatly increased loudness of voice.

4. Our vesper mouse delights in a role, the performance of which argues three facts: A high organization of the organs of the voice; delicate and skillful adjustment during use; a perfect condition as respects health. She can sing and eat at the same time. * * * Now this fact, in the case of our Hesperomys, that it could eat and sing at the same time, even admitting, what is probably true, that there are intervals of very short duration (so short as to be almost indiscernible) when the epiglottis closes to allow the food to pass down the gullet, demonstrates, as we think, that the organization of those parts was very delicate, and that the whole organism was in the very highest condition of health."

Although the particular mouse, above so pleasantly described, came from Florida, it is certain that the musical powers are not confined to any section, for several different species of various genera have afforded examples of more or less highly developed musical powers, as witness the following note quoted from the *American Naturalist* of 1871, p 171:

"A communication in the *Naturalist* some time ago in regard to musical mice, prepared me for a phenomenon which recently came under my observation, which otherwise would have astonished me beyond conception. I was sitting a few evenings since, not far from a half-open closet door, when I was startled by a sound issuing from the closet, of such marvelous beauty that I at once asked my wife how Bobbie Burns (our canary) had found his way into the closet, and what could start him to singing such a queer and sweet song in the dark? I procured a light, and found it to be a *mouse!* He had filled an overshoe from a basket of popcorn which had been popped and placed in the closet in the morning. Whether this rare collection of food inspired him with song I know not, but I had not the heart to disturb his corn, hoping to hear from him again. Last night his song was renewed. I approached him with a subdued light

and with great caution, and had the pleasure of seeing him sitting among his corn and singing his beautiful solo. I observed him without interruption, for ten minutes, not over four feet from him. His song was not a *chirp*, but a continuous song of musical tone, a kind of to wit-to-wee-woo-woo-wee-woo, quite varied in pitch. While I observed him I took for granted that he was a common house mouse (*Mus musculus*), but when he sprang from the shoe to make his escape he appeared like the prairie mouse (*Hesperomys michiganensis*), a species I had not however, observed before indoors. I have thus far failed to secure this little rodent musician, but I shall continue to do all I can in the way of popcorn to entertain him, and if his marvelous voice gives him the pre eminence in mousedom which he deserves, by the aid of natural selection I shall presently have a chorus of mice; in which case you shall receive their first visit.—W. O. Hiskey, Minneapolis, Minn."

The writer has been informed of many similar cases, making it certain that the musical performances described above, are in no way exceptional, but showing that considerable musical powers are universal among *Hesperomys*. That the song is not a voluntary expression of pleasure has been suggested by many. The most recent data in favor of the pathological nature of mouse music has been offered by Mr. Davis.*

While wandering about the house its tell-tale song gave notice of its wanderings. "When removing it from the trap to the cage, and many times afterward, it ran about a small room, and the most noticeable feature on these occasions was the unvaried song, it being especially loud if I caused the mouse to scamper around the room several times without stopping. When gnawing upon the exposed wood in the cage, when eating, or when disturbed in its nest, this singing was particularly loud; in fact, upon any exertion, the song was produced, varying in volume in proportion to the amount of exercise."

"It was just previous to, and for some time after the birth of two miserable little young that *Mus* sang most continuously."

It would be of great interest to determine by anatomical examination whether the singing mice are suffering from bronchial disease.

*Wm. T. Davis. The Song of the Singing Mouse. *Am. Naturalist*, 1889, p. 481.

Vesperimus sonoriensis LeConte.

THE SONORA MOUSE.

Mus leucopus Richardson, Zool. Journ., 1818; Fauna Bor. Am., 1829.
Hesperomys sonoriensis LeConte, Proc. Acad. Nat. Sci. Phila., 1853.
Audubon and Bachman, Quad. North America, 1854.
Baird, Mam. N. A., 1857; U. S. and Mex. Bound. Surv., 1859.
Hesperomys leucopus sonoriensis Coues, Monogr. N. Am. Rodentia, 1877.

The little animal known as *Hesperomys sonoriensis* is a resident of the western interior region and might be regarded as a permanent prairie variety of *H. leucopus* but for the fact that the two species are associated at the limits of their geographical range instead of fading insensibly into each other as geographical varieties of recent origin might be expected to do. Our collection embraces a considerable number of specimens collected at Brown's Valley and other points near the western line of Minnesota where this form is the most abundant mouse. There is a very remarkable uniformity in size and coloration which both are sufficiently unlike the deer mouse to be easily distinguishable. On the whole, the colors may be said to be considerably lighter and less conspicuous than in the deer mouse, but still they are bright and attractive. The white parts encroach more upon the dorsal area than in our more eastern mouse and the line of demarkation is more distinct, there being none of the gray on the hips usually seen in the latter, and the sides and lower parts are beautifully white. The brown portion of the tail is a narrow stripe and the back is not so conspicuously marked with black hairs as in *leucopus*. Besides these differences in the whole anterior portion, the pelage is sifted over with whitish so as to give it a grayish tinge, while only on the rump is found the bright reddish brown of our familiar species. Should the color not prove distinctive the marked difference in size is sufficiently conspicuous.

The following table fairly represents the limits of normal variation and in one case (No. 100) a specimen to some extent resembling the deer mouse.

No.	Nose to anus	Tail.	Nose to ear.	Nose to eye.	Hind foot.	Fore foot.	Ear.	Sex.	Date.
32	3.25(?)	2.44	0.88	0.56	0.87	..	.....	.....	Dec 4, 1883.
89	3.62	2.25	0.90	0.50	0.72	0.38	0.50	female	July 1, 1885.
90	3.38	2.40	0.75	0.45	0.71	0.35	0.50	female	"
91	3 60	2 25	1.00	0.50	0.70	0.35	0.51	male	"
98	3.55	2.35	0.95	0.50	0.70	0.35	.....	female	"
99	3.50	2.00	0.95	0.50	0.70	.....	.....	male	"
100	3.85	2.60	1.00	0.57	0.80	0.35	.....	male	"
101	3.80	2.36	1.05	0.50	0.75	.....	0.55	male	"
106	3.80	2.40	1.00	0.50	0.72	.....	.....	female	July 4, 1885.
107	3.75	2.20	0.98	0.49	0.70	.....	.....	female	

There is no evidence, so far as our state is concerned, that the three species of *Vesperimus* merge into each other. *V. michiganensis* and *V. sonoriensis* are associated westwardly and although the exact line of contact between the latter and *V. leucopus* has not been studied it is presumable from appearances that this line corresponds with the western forest limit and is quite sharp.

The westward range of the species includes Dakota, Montana, Wyoming, Nebraska, Kansas, Colorado, Utah, Arizona, New Mexico, Texas, and part of California.

The Arctic mice of this group resemble the present species in having short tails but for a reason quite different from that which would by assumed in this case. The color, moreover, in the latter is darker. The matter of coloration is so largely dependent on the humidity of the climate that our western mice, at least within the influence of the Red River valley, are much darker than typical *V. sonoriensis* of the plains. Of the habits we know nothing to distinguish them from the common deer mouse. They may be seen springing about among the high grass at times although probably less saltatorial than the deer mouse.

Vesperimus michiganensis Aud. and Bach.

THE MICHIGAN MOUSE.

(Plate XI.)

Mus michiganensis Audubon and Bachman, Journ. Acad. Nat. Sci. Phila., 1842; Quadrupeds N. A., 1854.

Hesperomys michiganensis Wagner, Wieg. Archiv., 1843.
Baird, Mam. N. A., 1857.

Hesperomys (*Vesperimus*) *michiganensis* Coues, Proc. Acad. Nat. Sci. Phila., 1874; Monogr N. A. Rodentia, 1877.

Mus bairdii Hoy and Kennicott, U. S. Pat. Offic. Rep. Agric., 1856.

The Michigan mouse is common throughout the upper Mississippi valley and the states adjoining and is of reasonably frequent occurrence in the south eastern parts of Minnesota. This mouse may be at once distinguished from the deer mice by its small size, small tail and feet and the darker coloration. Unless examined carefully the color will usually seem not greatly brighter than in the house mouse. The general gray of the upper parts is mingled with yellowish on the sides, especially upon the cheeks, as Audubon points out, while the whole back is very dark brown. (The colors are rather brighter than usual in our drawing.) The gray of the sides extends down the outside of the limbs to the wrist and ankle.

The head is hardly to be distinguished from that of the deer mouse but the ears are smaller although they are obviously margined with white and otherwise in color and form as in *V. leucopus.* The tail is about as long as in V. *sonoriensis* but is less densely hairy and has a broader dark stripe above. One of our Minnesota specimens (as figured) has both hands and feet snowy white while in more southern and eastern specimens they are said to be dark. The following measurements pertain to the specimen figured:—length 5.63 ; tail 2.38 ; head and body 3.25;sole 0.68;forefoot 0.37;nose to eye 0.50; nose to ear 0.87.

It will be seen that these measurements indicate a larger animal than usual, besides being one which in some other points approaches *V. leucopus.* Our Michigan mice are more domestic in their habits than the deer mice and may be encountered about buildings even in towns of some size. One was taken, in 1877, in the basement of the University at Minneapolis.

The range of the present species is rather more limited than that of other members of the subgenus but is nevertheless far less restricted than has been hitherto supposed. It is essentially a prairie animal, and will probably be found to be limited in range by the extent of the prairies as distinguished from the plains on the one hand, and the forest regions on the other. It may be found throughout the whole of the southern half of Minnesota, but is most abundant in the southwestern and southern portions. In Dakota it mingles freely with the Sonora mouse without exhibiting the least tendency to approach it in coloration, and on the east is gradually superseded to a very large extent by the deer mouse, from which it is even more evidently distinct. Upon the rolling prairies of the south and west it may be said to be alone in its own territory. Two very well marked varieties occur which, so far as the present writer's experience goes, are, in a general way, connected with open or more umbrageous stations. Both varieties are found together in some cases, but the majority of the specimens found in Dakota and to the south and west will undoubtedly be found to adhere to one type of coloration and those in the east to another.

On first encountering the Michigan mouse near Big Stone lake upon the western boundary I was inclined to imagine that a species hitherto unseen lay before me, so different was the whole *ensemble,* but comparisons and the variations exhibited by a large series of specimens made clear the essential consonance in most points with *V. michiganensis.*

Inasmuch as this varietal difference is quite different from that mentioned by Hoy and Kennicott as separating *H. bairdii* from *H. michiganensis* it may be well to define it more minutely.

The eastern Michigan mouse although much less bright than *H. leucopus* has on the sides a decided brownish cast, or even fawn color, while the typical western variety has scarcely a trace of any other tint than black and white except on the upper surface of the tail. About the head there is the same hoariness exhibited by other prairie mice, as though faded by the sun. As a rule there is a less sharply defined line of demarkation between back and belly than in more eastern specimens examined.

In all the Michigan mice examined the ear is white-rimmed in spite of Dr. Coues' assertion to the contrary. Although the dorsal dark area may not reach the hand there is invariably a dark blotch on the wrist which may or may not embrace the whole upper surface of the hand.

The following table of measurements, of which all but the last two refer to specimens captured near the western line of Minnesota, may show the variations in size and can be taken as fully trustworthy, having been made with great care from fresh specimens:

No.	Nose to anus.	Tail.	Nose to ear.	Nose to eye.	Hind foot.	Ear.	Sex.	Date.
108	3.00	1.90	0.90	0.45	0.73	0.60	male	July 5, 1885.
111	3.25	2.15	.....	.....	0.70	.....	male	July 5, 1885.
113	3.12	1.90	0.90	0.50	0.70	0.55	male	July 7, 1885.
117	3.20	2.00	.....	.....	.....	.....	male	July 7, 1885.
118	3.20	2.00	0.85	0.50	0.70	0.50	male	July 7, 1885.
119	3.45	2.20	.....	.....	0.70	.....	male	July 9, 1885.
21	3.25	2.37	0.87	0.50	0.68	.....	female	Nov., 1883.
83	2.80	1.90	.....	0.50	0.70	.....	male	? (Alcohol).

Subfamily ARVICOLINÆ.

The field mice, which are included in this section of the immense rat family, may be readily recognized, as a rule, by their rather clumsy and squatty form, blunt muzzle and small ears. Tail and limbs are generally short, while the eyes are small. The fur is often thick and fluffy, while the colors are predominatingly rusty brown. The north temperate regions of both hemispheres form the habitat of the majority of the species. None occur in South America. As in other northern mammals, there is rather a close conformity between the faunæ of Europe and America.

The anatomical characters are no less conspicuous. The incisors are broad and short. The molars are perfectly prismatic, and their growth is continuous, so that after the crowns

are worn off the pattern does not vary greatly with use. In almost all the species the molars are rootless. The palate is not flat, as in *Murinæ*, but variously complicated. The zygoma is not deflected as far downward as in *Murinæ*, and it is not emarginate at its anterior origin. The nasals are broad and short. The angle of the mandible is arched. The scapula is narrow, with long, slender acromium. The proportions of the limb bones are different from those common in *Murinæ*.

GENUS HYPUDÆUS ILLIGER.*

This small genus fittingly introduces the arvicoline group of rodents forming a transition as it does between the *Murinæ* or common mouse subfamily and the field mice or *Arvicolinæ*.

The separation of the genus from other field mice is a matter of convenience as well as morphologically demanded. The very few species are all inhabitants of the northern hemisphere and are so closely related that they might without serious impropriety be reduced to varieties of a single circumpolar species, *Mus rutilus* Pallas.

The external form is sufficiently like that of our common field mouse, *Arvicola riparius*, but the color is bright, all these mice deserving the adjective "red-backed". The red-backed mice are inhabitants of the woods as distinguished from the prairie mice and those so disposed may see in the color illustrations of protective coloration. The wood mice frequent decaying trees, the pulverent wood surrounding which commonly has a color very like that of the mice. The prairie mice are exposed to greater danger and have a color not unlike that of the sear grasses or the earth.

The genus is so essentially arvicoline that the diagnostic features may take the form of points varying from that type in the direction of the *Murinæ*. In form arvicoline, but rather less slender and with longer ears. Colors bright or, at least, strongly red. Molars each with two roots (instead of rootless as in *Arvicola* or fully rooted as in *Murinæ*). The teeth are otherwise as in the field mice but less completely broken up

*In using this name for the genus lately renamed *Evotomys* by Coues, we follow Keyserling and Blasius, Prof. Baird and European authors generally. It seems a misfortune that in nomenclature as well as in more vital matters there should be no articulation between the scientific labors of the two continents. Dr. Coues has in the case of this genus (as well as frequently elsewhere) shown the intimate relations between the mammals of Europe and North America. It is therefore a positive misfortune if the same group bears different names on the different sides of the Atlantic. It seems that the technicality involved might be well ignored in this case and the above name, which has been more or less fully instated in the literature of both continents, retained for this group.

into distinct prisms. The faces of the upper molars especially present less complicated figures than usual; instead of alternating triangles we find single irregular figures extending entirely across the tooth. The skull is very broad and is greatly inflated in the perotic region, the auditory bullæ being larger than in any other mouse. The bony palate is broad and rather short and abruptly truncate at the posterior nares (not with a second shelf before reaching the basis cranii). The pterygoids are not very prominent. The cranium is large while the facial portion is greatly reduced and the interorbital distance is quite small. The posterior extremity is proportionally large but there are no indications of either saltatorial or fossorial capacities.

It has been shown by Dr. Coues that in America we have but a single species of this genus, *H. rutilus* Pallas, which occurs in its typical form throughout the Arctic portions of the continent. It is thus seen that *H. rutilus*, like so many Arctic animals is circumpolar in distribution and has become modified southwardly so as to give rise to varieties which may be diverse in the western and eastern hemispheres. The southern varieties have been called *gapperi* in America and *glareolus** in Europe, there being nothing to show them distinct.

Hypudæus rutilus var. gapperi? VIGORS.

(Var. *glareolus* Sund.?)

Arvicola gapperi VIGORS. Zool Journ. v, 1830.
DEKAY. Zool. of New York, 1842.
SCHINZ. Synop. Mam. ii, 1845.
Hypudæus gapperi BAIRD. Mam. N. Am., 1857.
Arvicola fulva AUDUBON and BACKMAN. Journ. Acad. Nat. Sci. Phila. viii, 1842.
WAGNER. Wiegmann's Arch., 1843.
Arvicola dekayi AUD. and BACK. Quad. N. Am. iii, 1854.
Evotomys rutilus gapperi COUES. Proc. Acad. Nat. Sci. Phila., 1874; Monogr. N. Am. Rod., 1877.

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* *Mus rutilus* var. Pallas.
Mus glareolus Sundeval, 1840.
Mus glareolus Schreber.
Hypudæus hercynicus Mehlis.
Arvicola rubidus Longchamp.
Arvicola rufescens Longchamp.
Arvicola riparia Yarrell, Jenyns.
Arvicola pratensis Bell, Macgillivray.
Hypudæus glareolus Wagner.
Arvicola glareolus Giebel.
(*H. nageri* Schinz. May not belong here, it being an Alpine species imperfectly described.)

The close relationship between this variety and *H. rutilus* was first shown by Coues in the Proceedings of the Academy of Natural Sciences of Philadelphia in 1874. The differences consist in a somewhat greater size and a considerably greater development of the extremities in accordance with the general law that the extremities are shorter in northern individuals of a species extensively distributed than in southern examples of the same species. If the size be really less than in *H. rutilus* it forms an exception to the remainder of the law that the absolute size is usually greater. The colors are darker, especially the sides which are a grayish brown instead of having the milk tinge of *H. rutilus.*

In general form there is nothing to distinguish this interesting animal from the common field mouse. It can be at once distinguished, however, by the color and the greater development of the ears. These organs appear quite prominently above the fur and are hirsute, while near the base of the antitragus is a tuft of stiff hairs longer than the ear itself.

The middle of the back from the crown to the root of the tail is of a strong, rusty red color, given a grayish cast by numerous black hairs sprinkled through the pelage. On the sides the red is largely replaced by brown. so that the resulting color is much as in *Arvicola riparius.* The bases of the hairs everywhere are plumbeous. About the face the color becomes a grizzly gray, in old specimens at least. Below greenish white of various degrees of purity is the prevailing color, the fur being much lighter color than in *A. riparius.* The feet partake in the same coloration. The tail is distinctly bicolored, the upper surface being, as usual, darker than the prevailing color of the back. The vibrissæ are rather longer than in *A. riparius.* Considerable variations in the coloration occur, the breadth of the red stripe especially being far from constant, either in width or intensity.

The following measurements may be taken as a very fair showing of the size of adults, the first being taken in autumn, the second in spring, and in adjacent localities:

NUMBER.	Total length	Head and body.	Tail.	Nose to eye.	Nose to ear	Fore foot.	Hind foot.
31. (Female ?).....	5.70	4.0	1.70	0.50	0.95	0.31	0.75
72. (Male).....	4.90	3.7	1.20	0 45	1.30	0.40	0.70
Averages....	5.13	3.6	1.53	0.44	0.85	0.37	0.72

Coues' averages, published in his monographs of North American Rodentia, are placed in the third line for convenience of comparison.

The tubercles on the feet furnish reliable generic, if not specific, characters. There is, in this species, a large pad at the base of the first and second digits of the hind foot; a smaller one lies midway between the third and fourth; the largest one of all is near the base of the fifth digit, while two smaller ones, one on the outside, the other on the inside (the latter farthest back) lie behind them. The under surface of the toes appears scutilate, and the sole is punctate, while all that portion back of the pads is sparsely hairy. The fore foot has five pads, and the thumb nail is spade-shaped. The nasal pads are very small, and the head is blunt and stout, in fact the aspect is, as has been said, very much like that of a field mouse.

While our information does not permit us to very minutely describe the range of the species, we know of its occurrence in most parts of the state. The following localities may be named: Hinckley, Pine county; Milaca, Mille Lacs county; Minneapolis, Hennepin county; Brown's Valley, Traverse county; Ortonville, Big Stone county, and points on the Red and Minnesota rivers. It was not found on the Mississippi at Watab, where *Arvicola riparius* is very common; nor can it now be found near Minneapolis, though once common.

In the eastern part of the United States this variety is found as far south as Massachusetts, and in New York, Michigan and Wisconsin, as well as in Washington. It merges insensibly into the typical *H. rutilus* to the north, so that to lay down an arbitrary geographical range is impossible.

The writer has observed these mice very abundant in dense woods running actively from fallen log to stump or brush-heap in broad day light, the rusty red color being scarcely distinguishable from the red sawdust which often forms the soil or the pine needle carpet. The food can only be surmised, but the stomach is quite different from that of *Arvicola*, being more complicated and it may be presumed that grass seeds do not enter as largely into the diet as in the latter. By the first of April sexual functions are at their hight, the testes measuring 0.3.

The following additional measurements are appended although they are not all from fully adult specimens. These are from specimens collected near Big Stone lake on the western line of Minnesota. Although by no means abundant it is not rare in the region of the upper Minnesota:

No.	Nose to anus.	Tail.	Nose to ear.	Nose to eye.	Hind foot.	Fore foot.	Ear.	Sex.	Date.
88	3.60	1.30	0.94	0.45	0.70	0.30	.....	?	July, 1885.
96	2.90	1.20	.....	.....	0.65	.....	.....	?	July, 1885 (mutilated)
97	.....	1.60	0.90	0.50	.....	.....	0.38	male	July, 1885 (mutilated)
116	3.80	1.70	0.90	0.50	0.70	.....	.....	female	July 7, 1885.

"It feeds upon beechnuts and a variety of seeds, berries, and roots, and also, at certain times in the winter season, upon the bark of shrubs and trees.

"The beech, maple, ash, and bass suffer most severely from its attacks, and in the order named. The bark is generally removed in irregular areas from the large roots just above the ground; but sometimes saplings, and even trees a foot or more in diameter are completely girdled to the hight of three or four feet. The damage thus done to our deciduous groves is sometimes great, but does not compare with the ravages committed by the field mouse (*Arvicola riparius*).

"The wood mouse is terrestrial, like the other members of the *Arvicoline* series, and commonly lives in burrows in the ground. It sometimes makes regular runways similar to those of the field mouse, but usually travels freely over the surface. . .

"The nest of the red-backed mouse is usually in this [Adirondack] region, placed in a burrow in the earth, although it is sometimes found in a half decayed log or under the roots of a stump."—*Mammals of the Adirondacks*, p. 271.

Genus ARVICOLA, Lacepede.

The genus is employed in the restricted sense as indicated by Coues.

Size moderate or rather large; form stout and clumsy; feet and tail short, the latter densely covered with hair. Muzzle blunt and covered with fur, except the small nasal pads. The eyes are small, and situated about half way between the muzzle and the hidden ears, which have a large antitragus. The incisors are not grooved, broad. Molars $\frac{3}{3}$—$\frac{3}{3}$, prismatic; the prisms are very acute, the anterior upper one having five prisms, of which one is anterior, the following ones arranged alternately; the middle molar has four prisms, one being anterior and two exterior; posterior upper molar with (apparently) four to seven prisms, the variability arising from the greater

or less subdivision of the fourth treffle. The anterior lower molar is very long and variously formed, the anterior prism being more or less complicated; the middle molar has four or five prisms, the last being transverse, the others alternating; the last molar consists of three simple prisms in a series.

The skull is never more than twice as long as broad. Anterior palatal foramina very short. Nasals short. Coronoid process extending to the hight of the condyle.

The four American subgenera are as follows:

SUBGENUS MYONOMES, RAFINESQUE.

Back upper molar with two external triangles, one internal triangle, an anterior loop, and a posterior crescent-like figure (this with some variability). Middle upper molar with two internal triangles. Front lower molar with three internal and two or three external triangles. Ears covered by fur, rounded; antitragus well developed. Tail longer than the head. Sole six-tuberculed; claws of forefeet small. Size and fur ordinary.

1. *Arvicola riparius* ORD.
2. *Arvicola borealis* RICH.
3. *Arvicola xanthognathus* LEACH.
4. *Arvicola richardsoni* AUD. and BACH.
5. *Arvicola longicaudatus* MERRIAM.

SUBGENUS CHILOTUS, BAIRD.

Back upper molar with one external triangle and a posterior trefoil; anterior lower molar with three inner and two or three external triangles. Ears small, orbicular, helix incurved all round. Size small. Tail longer than head. Claws short. Two imperfectly known species from the Pacific coast and one from Dakota.

6. *Arvicola oregonus* BACH.
7. *Arvicola pallidus* MERRIAM.
8. *Arvicola curtatus* COUES.

SUBGENUS PEDOMYS, BAIRD.

Back upper molar with one external triangle; middle upper molar with one internal triangle; front lower molar with two internal and one external triangle. Tail about equal to head. Fore claws short. Size medium, fur ordinary.

9. *Arvicola austerus* LE CONTE.
10. *Arvicola minor* MERRIAM.

SUBGENUS PITYMYS, MCMURT.

Back upper molar with one external triangle and a posterior trefoil; middle upper molar with one internal triangle; front lower molar with two internal and one external triangle. Tail shorter than head. Fore claws fossorial. Size small, fur mole-like.

11. *Arvicola pinetorum* LE CONTE.
12. *Arvicola quasiater* COUES.

Arvicola riparius ORD.

COMMON MEADOW MOUSE.

(Plate XII.)

Mynomes pratensis RAFINESQUE. Am. Month. Mag., 1817.
Arvicola pennsylvanica ORD. Guthrie's Geogr., 1815.
WAGNER. Suppl. Schreber's Säuget.
SCHINZ. Synopsis, 1845.
AUD. AND BACH. Quad. N. A., 1849.
LECONTE. Proc. Acad. Nat. Sci. Phila., 1853.
Arvicola palustris HARLAN. Fauna Amer., 1825.
Arvicola riparius ORD. Journ. Acad. Nat. Sci. Phila., 1825.
DEKAY. Zool. of New York, 1842.
AUD. AND BACH. Quad. N. A., 1854.
LECONTE. Proc. Acad. Nat. Sci. Phila., 1853.
BAIRD. Mam. N. America, 1857.
GIEBEL. Säugethiere, 1859.
GODMAN. Amer. Nat. Hist., 1860.
ALLEN. Bull. Mus. Comp. Zool. No. 8.
Arvicola (Myonomes) riparius COUES. Proc. Acad. Nat. Sci. Phila., 1874.
COUES AND YARROW. Zool. Expl. W. 100th Mer., 1876.
COUES. Monogr. N. A. Rodentia, 1877.
Arvicola riparius longipilus KENNICOTT. Agric. Rep. U. S. Patent Office for 1856.
BAIRD. Mam. N. Amer., 1857.
Hypudæus riparius MAXIMILIAN. Arch. Naturg., 1862; Verzeichniss N. Amer. Säuget., 1862.
?*Hypudæus ochrogaster* WAGNER. Schreber's Säuget., iii.
Arvicola xanthognatha HARLAN. Fauna Amer., 1825.
GODMAN. Amer. Nat. Hist., 1826.
SAY. Long's Exped. to Rocky Mts., 1823.
DEKAY. Zool. of New York, 1842.
LINSLEY. Amer. Journ. Sci., 1842.
Arvicola alborufescens EMMONS. Rep. Quad. Mass., 1840.
DEKAY, N. Y. Zool. i, 1842.
Arvicola hirsutus EMMONS. DEKAY, ll. cc.
Arvicola nasuta BACHMAN. Journ. Acad. Nat. Sci. Phila., 1842.
AUD. AND BACH. LECONTE.
Arvicola oneida DEKAY. LECONTE, ll. cc.
Arvicola rufescens DEKAY. Zool. New York, 1842.
Arvicola occidentalis PEALE. Mam. U. S. Expl. Exped., 1848.
LECONTE, AUD. AND BACH., BAIRD.
Arvicola montana PEALE, l. c., AUD. AND BACH., BAIRD, NEWBERRY.
Arvicola edax LECONTE. Proc. Acad. Nat. Sci. Phila., 1853.
AUD. AND BACH., BAIRD.
Arvicola borealis LECONTE. Proc. Acad. Nat. Sci. Phila., 1853.
Arvicola trowbridgei BAIRD. Mam. N. A., 1857.
Arvicola longirostris BAIRD. NEWBERRY, P. R. R. Rep., 1857.
Arvicola modesta BAIRD. Mam. N. A., 1857.
Arvicola rufidorsum BAIRD. Mam. N. A., 1857.
Arvicola breweri BAIRD. Mam. N. A., 1857.

American naturalists are greatly indebted to Dr. Coues for the very complete and lucid discussion of the meadow mice of America, particularly as respects this common and widely distributed species. What otherwise would have been a mere suspicion, or, at best, a moral certainty, is by him placed beyond dispute—namely, that the majority of the innumerable species related to *A. riparius* are synonyms pure and simple. The difference of opinion which may still exist as to the specific validity of those forms which show tangible differences, will be comprehensible, and will be founded upon different interpretations of facts, and not upon the misunderstanding of facts.

Arvicola riparius, the common meadow mouse, is perhaps the most abundant, as it is the most widely distributed of our native mice. It makes its home in the weedy corners of fields, along hedge rows, in the close grass of the meadow—anywhere that affords shelter and access to its food. In the autumn it leaves its summer habitation and makes a new domicile in the corn shocks or grain stacks, or beneath the granaries adjoining, showing its appreciation of the thrifty care of the farmer by helping him dispose of his harvest. The farmer boy enlivens the monotonous task of corn husking by a merry scramble after the furry pilferers, as each shock is removed, assisted, it may be, by an eager terrier, which tears the large, spherical nests with excited haste.

Allowing for great local or accidental variations, the following description will make the animal recognizable :

Body four to five inches long, stout ; members small, particularly the forefeet and tail ; head blunt. The forehead is curved, the muzzle very blunt and furry, the eyes small, not prominent, and placed about half way between the nose and ears. The ears are covered with hairs on both sides, and do not overtop the fur, having a valve-like antitragus closing the opening. The forefeet are small and are employed as prehensile organs extensively, the animal naturally supporting itself, when at rest, upon the hind feet almost exclusively.

The proportions, as well as the normal size, may be gathered from the following measurements, which will be found to be very constant in *adult* specimens from the southern part of Minnesota:

Number.	Trunk	Tail.	Nose to eye.	Nose to ear.	Hind foot.	Fore foot.	Spread of hind legs.	Spread of fore legs.
75. (Male).....	4.00	1.35	0.50	0.90	0.70	0.40	3.9	3.25
76. (Female)...	4.30	1.40	0.45	1.00	0.70	0.40	4.1	3.35

The ear is 0.45–0.50 high, the lower incisor 0.30, upper incisor 0.20. It is believed that there is normally about the above-indicated difference between males and females of the same age and at the same place. The above were chosen because the two were taken under circumstances indicating that they were a pair. In autumn the averages of mice collected would be quite unreliable, and it seems quite probable that more than a single winter is necessary to the attainment of the full size. However, mice collected in spring about Minneapolis have proven very uniform in both size and color. A very large female, collected in October, 1883, measured about five inches, with a tail measuring 2.0, hind feet 0.75, and fore feet 0.43.

The averages of 114 specimens of this species from east of the Mississippi, as given by Coues, are as follows: Trunk, 4.33; tail, 1.59; hind foot, 0.78.

In our opinion the average of a large series of Minnesota specimens would be considerably less, and quite obviously so if the northern part of the state were represented.

The color is dark brown with reddish sifted through the pelage. Usually the whole back from the nose to the tail is uniform dark brown, the upper surface of the tail being somewhat darker, while the sides of the body are appreciably warmer. The upper surfaces of the feet are brown, also. Below the fur is ashy white, more whitish about the mouth. The lower surface of the tail is more or less distinctly white. Winter specimens are very uniform in color, and there is no sexual differentiation as in *Fiber*. The vibrissæ are short and dark.

The range of this species is very extensive yet it would seem that its true home is the eastern part of the United States from the northern part of the Gulf states northward to Labrador. Farther west the northern limit of typical *Arvicola riparius* seems to lie within the U. S. boundaries. Although the species extends westward to the Pacific it tends to lose its integrity and merges in varieties of greater or less permanence. Northwardly and westerly from the middle of Minnesota the size drops rapidly and in the Red River valley the measurements are never up to the average of the type. Still farther north it would seem that the species can not go without great difficulty or at the expense of much of its normal size. It here becomes variety *borealis*. It may be suggested that constant migrations (after the analogy of the migratory habit of the

Lemmings) tend to confuse the effect of climate, in which case we may understand why variety *borealis* may be occasionally found as far south as Moorhead, Minnesota (a fact not hitherto reported) and why, on the other hand almost typical *riparius* sometimes reaches Alaska. It is, at any rate, certain that this section (*Myonomes*) of *Arvicola* when it becomes acclimated takes on the characteristics of an arctic variety—this our explanation—with larger body and smaller extremities. This phase constitutes variety *xanthognathus* or the yellow cheeked variety of Alaska and the arctic regions. The relative size of true *riparius* and *borealis* will be found given under the osteology of the latter. (Anatomical details of the present species below.)

We have kept specimens of the meadow mouse in confinement and found it an engaging pet easily domesticated and accommodating itself to its new circumstances well. It is surprising how little the fore feet are used in its daily activities. Although perhaps less amusing than the white-footed mouse in confinement it is sprightly and active. The sight is rather defective and the senses not acute. Its food consists largely of grasses and the stomach will usually be found full of green material although the grain is also highly relished. I have been able to detect no preference between the various cereals. Wheat is secured in the field by cutting the halm off repeatedly until the ear is brought within reach. The meadow mouse is not fossorial strictly, excavating at most but shallow runs below the surface. The teeth are used expertly in gnawing through boards if a light is seen through, but not so much so apparently as in the case of our domestic mice. These wild mice are very fond of water, lapping it eagerly if for a few hours deprived of it. They are also very neat in their personal habits. They fall an easy prey to birds of prey on account of their imperfect sight but would otherwise multiply very rapidly. They like well on sunny afternoons to play about, running through the galleries or roads they have made through the high grass. These paths lead from one covert to another and are not burrows but pass under roots or fallen logs or boards or brush piles and are beaten smooth by constant use. On such isolated places as bushy islands in the middle of some river they become numerous and venturesome.

It has already been mentioned that the field mice are now found in greater numbers than elsewhere, upon the low grass-covered islands in our rivers, where, during the summer, at least, they are to a certain extent, exempt from forays of

domestic cats and other enemies. In such places their nests may be found in almost every suitable grass tussock, and under fallen trees or driftwood. Such islands are, of course, flooded during a short period in spring, and these freshets are times of great excitement among the mice which have domiciled themselves under the boards and riffraff left by the last flood.

In April, 1885, while in camp upon a large low island at the head of lake Pepin, a hard storm of rain and snow caused a sudden rise in the river of nearly fifteen inches—sufficient, at least, to flood the greater part of the island and float away many traps set for mice and shrews in various places. Near the tent was a broad bay the low shores of which, for acres in extent, were covered with driftwood, which furnished concealment for innumerable mice, *Arvicola riparius*. When the river began to rise the water oozed beneath the boards, and before the observer was really aware of the encroachment of the waters the whole area was afloat.

The night was clear and moonlit, and as we stood watching the most insidious approach of the waters, wondering if we should be compelled to remove our camp, we were astonished by a confused rustle and murmur not unlike that produced by the wind among dry leaves. This we were at a loss to account for since the night was perfectly still. At our feet, however, something tangible appeared in the shape of a group of mice fleeing from the waters, creeping out from their hiding places, in evident alarm, which was expressed in querulous cries as well as by their excited and uncertain movements. To use a common expression, the whole tract was "alive" with mice fleeing for their lives toward the higher open ground behind. The picture was that of the Ohio floods, with mice rather than men as actors, and furnished an illustration *apropos* of Burns's lines, "The best laid schemes of mice and men gang aft agley." A pair of great-horned owls, whose nest was hard by may have profited more by this unexpected hegira than the naturalists of the party but, presumably, were less affected by its novelty than they.

Arvicola riparius var. borealis Rich.

It is interesting to compare a specimen of *Arvicola* sent us by Prof. W. W. Cooke, of Moorhead, Minnesota, with the measurements and the description of the arctic form called *borealis* by Richardson. This specimen, collected March 15th, 1885,

although received in too poor condition to be preserved or satisfactorily studied, attracted attention on account of its obviously reduced size. There seemed to be no reason to suspect that it was not fully mature, while its measurements excluded it from normal *A. riparius*, which, except in the matter of size, it completely resembled.

Length of trunk, 3.50; tail, 1.30; sole, 0.70; palm, 0.41; nose to eye, 0.40.

In the absence of other specimens or further information as to the presence or absence of normal *A. riparius* in the Northwestern part of the state this stands as an isolated case of little value, except as it may direct attention to this question whether we have a permanent boreal variety of *Arvicola* in Minnesota.

As there is little or nothing in the form of the bones of *A. borealis* to distinguish it from *A. riparius* proper, the following measurements may serve to indicate the proportions of both forms: The upper number (units = $\frac{1}{100}$ inch) in each case refers to *A. borealis*, the lower to *A. riparius*. Total length of skull, $\frac{90}{100}$, (*i. e.* in *borealis* 0.9 in *riparius* 1 inch); zygomatic width $\frac{49}{60}$; length of nasals, $\frac{31}{26}$; length of temporals, $\frac{36}{40}$; medial length of parietals, $\frac{30}{21}$; length of molar series, $\frac{30}{25}$; length of upper incisors, $\frac{16}{26}$; length of scapula, $\frac{40}{50}$; length of humerus, $\frac{45}{55}$; length of radius, $\frac{45}{55}$; longest metacarpal, $\frac{15}{18}$; pelvis, $\frac{65}{80}$; femur, $\frac{49}{66}$; tibia, $\frac{64}{80}$; free portion fibula, $\frac{30}{40}$; longest metatarsal, $\frac{29}{30}$; (It is worthy of notice that the difference in size, so noticable in all other measurements, disappears in comparing the length of bones of the hand and foot, although the size in other respects is greater in the larger animal). The seventeen caudal vertebræ, $\frac{140}{190}$. The number of caudal vertebræ seems to be the same, but a greater diversity in size is exhibited here than elsewhere. The last seventeen vertebræ were measured in each case.

Arvicola (Chilotus) pallidus MERRIAM.

Quite recently Dr. Merriam has described from Dakota a species of the subgenus *Chilotus*, which may yet be encountered in Minnesota.* The species is said to strikingly differ from the other known North American species of *Arvicola* in the extreme paleness of coloration and the extreme shortness of tail.

*C. HART MERRIAM. Description of a new species of Field Mouse (*Arvicola pallidus*) from Dakota.

"*General Characters.*—Size medium, nearly equalling that of *Arvicola riparius* (average total length of four specimens, 126.25 mm.) Tail very short (average length in four specimens, 23.75 mm. from actual base, apparent length only about 18 mm.) with a long terminal pencil. Ears medium, thick, well haired, superior border inflexed, giving them a prominence not seen in flat ears of the same size; antitragus medium (smaller than in *A. oregonus*), its anterior border becoming continuous with the anterior base of the auricle, thus forming a low rim in front of the meatus as in *A. oregonus* and *Synaptomys cooperi*. Fur everywhere long, full and soft.

"*Color.*—Upper parts everywhere uniform pale, buffy-gray, slightly grizzled by the admixture of black-tipped hairs; under parts white, the plumbeous color of the base showing through in places on the belly; tail more or less obscurely bi-color."

"Total length—(1) male, 124 mm.; (2) female, 121 mm.; (3) male, 133 mm.; (4) female, 127 mm. Tail—(1) 25 mm.; (2) 20 mm.; (3) 25 mm.; (4) 25 mm. Hind foot—(1) 18.25 mm.; (3) 18.7 mm.; (4) 17.5 mm."

"Mr. Bailey states that "the pallid *Arvicolas* seem to be common at Fort Buford. They show a decided preference for the north side of steep hills. I have not found them on the south, southeast or southwest sides. The only reason I can suggest for this distribution is that the twilight (their favorite hour) is longer on the north side. The hills where I found them are all steepest on the north side, which may have some effect, though there seems to be no difference in the vegetation on different sides." "Their food seems to consist largely of the flowers of certain plants. When these plants grow near there are usually pieces of stems and blossoms of *Liatris graminifolia* and *Artemisia frigida* lying about, but many other plants and grasses seem to be eaten. They feed largely upon the seeds of *Eurotia lanata*. Probably the bulbs of *Liatris graminifolia* form a part of their diet, as is the case with *Arvicola austerus*." "I have caught several grasshopper mice (*Onychomys leucogaster*) and western white-footed mice (*Hesperomys leucopus sonoriensis*) at their holes, and think these species either drive out the *Arvicolæ* or else inhabit the old holes." They are found on the edge of the "Bad Lands" and from the fact that they live entirely in the hills and from their food it may be inferred that their habitat is the "Bad Lands."

SUBGENUS PEDOMYS, BAIRD.

Though no member of the sub-genus has been encountered in the progress of these investigations, it is certain that parts of Minnesota fall within the range of *P. austerus* as well as, possibly, of *P. curtatus*.

The characters given by Coues are as follows:

"Postero-superior molar with an anterior transverse loop, two interior triangles, one exterior triangle, and a posterior U-, V-, or Y- shaped loop (as in *Pitymys* and *Chilotus*). Medio-superior molar with an anterior, two exterior, and only one interior triangle (lacking the supplementary postero-interior spur or triangle of *Myonomes*). Antero-inferior molar with a posterior transverse loop, two interior closed triangles, one exterior closed triangle, another exterior and another interior open triangle, and an anterior irregular trefoil. * * Perfect plantar tubercles only five."

Arvicola (Pedomys) austerus LEC.

Very similar to *Arvicola riparius* but more compactly formed, and with harsher pelage. The color is a muddy brown above and a rusty plumbeous below; four inches long; tail 1.25; hind foot 0.70.

Since writing the above, Dr. Merriam has described* a new variety of *A. austerus* differing from the type chiefly in size and living upon the upland prairies. This mouse was first collected by Mr. Vernon Bailey, chiefly from Dakota, but the range also includes portions of western Minnesota, about Ortonville. The description is sub-joined.

Arvicola austerus minor MERRIAM.

"Type $\frac{3827}{4406}$, male, Merriam collection. From Bottineau, Turtle Mt., Dakota, Aug. 27, 1887.

Description of Type.—Similar to *Arvicola austerus*, but much smaller; length from end of nose to tip of tail vertebræ (measured in the flesh), 133 mm.; tail vertebræ, 36 mm.; hind foot, 16.5 mm.; ears rather prominent, slightly overtopping the fur.

Color.—Upper parts uniform grizzled gray; under parts whitish, washed with pale cinnamon. Viewed from behind, looking away from the light, the whole head, sides and back appear to

*DR. C. HART MERRIAM. Description of a New Prairie Meadow Mouse (*Arvicola austerus minor*) from Dakota and Minnesota. *American Naturalist*, 1888, p. 598.

be closely lined with silvery. The fur of the belly is plumbeous basally and nearly white apically. There is no sharp line of demarkation between the color of the sides and that of the belly. Tail bicolor, the light color of the under surface reaching well up on the sides."

"Other specimens from Elk River have the upper parts strongly suffused with brown, and the belly strongly washed with cinnamon, while in others the under parts are of the 'muddy rust color' so often seen in true *austerus*."

GENUS SYNAPTOMYS, BAIRD.

This genus, charcterized by Coues as "the most remarkable genus of the family," is very capricious in its distribution and thus is considered very rare.

"Root of inferior incisor ending abruptly opposite the last lower molar. Faces of superior incisors longitudinally grooved near the outer edges. Construction of molars and general cranial characters as in *Myodes* (Lemmings); palate ending as in typical *Arvicola;* external characters as in *Arvicola;* ears equaling or overtopping the fur; tail equal to or longer than the hind foot; pelage very soft and full."

Synaptomys cooperi BD.

Myodes (*Synaptomys*) *cooperi*, BAIRD. Cat. in Mam. N. A., 1857.
Synaptomys cooperi, BAIRD. Mam. N. A., p. 558, 1857.
COUES. Proc. Acad. Nat. Sci. Phil., 1874; Monogr. Amer. Rodentia, 1877.
QUICK and BUTLER. Am. Nat., Feb., 1885.

The only specimen of the single species of *Synaptomys* as yet found in Minnesota was collected by O. E. Garrison in Benton county and is at present in the National Museum (No. 10575). The pelage is described as very soft and full, and the color as much resembling *A. riparius*. Messrs. Quick and Butler have given the following information regarding the habits of this interesting species: It breeds from February to December, and was never known to bring forth more than four young at one time. There is one pair of pectoral and one pair of inguinal mammæ (Coues says *two* pairs of pectoral and one pair of inguinal). In color, specimens are, as a rule, darkest when just reaching maturity. The nest of this species is always under cover, generally in a hollow stump or log, and is composed

of fine grass. It is not so securely built as the nests of some of the other species of this family. Cooper's mouse lives in winter chiefly upon the stems of blue grass and the more tender portions of white clover. In November, 1883, a large quantity of the tuberous roots of the "Wild Artichoke" (*Helianthus doronicoides*) were found in the storehouses of a colony of these mice.

GENUS ONYCHOMYS, BAIRD.

MOLE MICE.

This genus is of particular interest in as much as it contains three varieties of mice which, from their inaccessible station and secluded habits have seldom gained admittance to natural history museums or received the attention of naturalists. This interest is enhanced by the fact that the genus is evidently very closely allied to *Vesperimus* but has developed in a direction entirely different from that group ; and its species, externally and in habits, vary greatly from the deer mice. Fossorial prairie or desert animals living largely on insects might be expected to differ greatly from such saltatorial and gramnivorous animals as *Vesperimus* contains.

The mole mice are distinguished from their relatives by the compact arvicoline form, short tail and hind legs, well developed anterior extremities with fossorial claws, and the soft mole-like character of the pelage. The hasty observer would refer the animal to *Arvicolinæ* rather than to the sigmodont *Murinæ ;* indeed prince Maximilian, who was the first to meet the genus, referred the *O. leucogaster* to *Hypudæus.* As we have specimens of none of the genus except *O. leucogaster* var. *pallidus* the reader is referred to the discussion of that variety for a description of the anatomical peculiarities. It seems that, in view of the many points of divergence in structure and habits, there should be no hesitation in separating the mole mice generically from *Hesperomys.*

Onychomys leucogaster MAXIMILIAN.

MISSOURI MOLE-MOUSE.

Hypudæus leucogaster MAXIMILIAN, Reise in das Innere N. America, 1841.
Mus missouriensis AUDUBON AND BACHMAN, Quad. N. A., 1851.
Hesperomys (Onychomys) leucogaster BAIRD, Mam. N. A., 1857.
COUES, Proc. Acad. Nat. Sci. Phila., 1874; Monogr. N. A. Rodentia, 1877.
Hesperomys leucogaster MAXIMILIAN, Arch. f. Naturg. xviii, 1862.

The single species thus far found under the genus *Onychomys* has differentiated into three more or less distinct geographical races or varieties. Of these but one is found in Minnesota and that only upon the western boundary and a very short distance east of it.

The typical form is stated to be restricted to the upper Missouri river region, and is described as follows:

"Color above, grayish-brown, passing into yellowish-red, and finally into a stripe of fulvous on the sides. Feet, including outer surface of the forearm and under surface of the body and tail, white."—*Baird.*

"Beneath, snow-white; above, mouse-brown, with darker dorsal area. Tail twice the hind foot or less; much less than half the head and body. Fore foot more than half the hind foot. Ear about 0.50 high."—*Coues.*

"The chief distinguishing feature in coloration, as compared with *Hesperomys leucopus*, is the mostly white muzzle.—"*Coues.*

The following measurements from No. 7492 of the national museum, are selected as fairly illustrating the proportions: Nose to tail, 4.25; tail, 1.65; hind foot, 0.88; fore foot, 0.50; nose to eye, 0.60; nose to ear, 1.00; ear, 0.50. The skull of a somewhat smaller specimen measured 1.07 (Coues).

Onychomys leucogaster var. **torridus** COUES.

Was founded upon a single alcoholic specimen from Arizona, which differs from the typical form of the species in having rather larger ears and tail and smaller fore feet. The colors are warmer. The following is Dr. Coues' diagnosis:

"Beneath, tawny-white [?]; above brownish fulvous, with no darker dorsal area. Tail about two and a half times the hind foot; almost half as long as head and body. Fore foot half the hind foot. Ears about 0.75 high."—*Coues.*

Without discussing the characters on which this variety is founded, we may remark that in the only form which we have seen, the proportional length of the tail and limbs were found to be subject to considerable variation, and that even while the exact pattern of coloration was maintained. Coues gives the following measurements of the specimen described: "Nose to tail, 3.75; tail, 2.00; hind foot, 0.80. fore foot, 0.40; nose to eye, 0.50; nose to ear, 0.95; ear, 0.70.

Onychomys leucogaster var. **pallidus**, var. n.

O. leucogaster var. *pallidus* HERRICK. Thirteenth Ann. Rep. Geol. Nat. Hist. Surv. Minn., 1884.

This variety is based upon a series collected near the sources of the Minnesota river and the Bois des Sioux river in Dakota, which differs so completely in coloration from either of the above varieties as to be entirely incompatible with any description as yet given of *O. leucogaster*, while at the same time preserving the essential characters of the species.

Upon first encountering the form while encamped on the shores of Lake Traverse, the writer was at a loss to classify his find, for, in coloration and form, it entirely differed from any description or figure known to him. It was at once set down as an *Arvicola* on the strength of its compact, obtuse form and burrowing habit, although the large ears and a certain vague suggestion in the appearance hinted at *Hesperomys*. It was necessary to examine the teeth before conviction was reached that we had to do with a *Hesperomoid* type. The mole-like appearance and habit at last furnished memory with the clue and we recognized our capture as *Onychomys*.

It will be most satisfactory to transcribe the description made in our diary from the recently killed specimen, as being quite unprejudiced by thought of comparison with other species.

Description of No. 103, collected July 4, 1885: "Color nowhere other than black and white or a mixture of the two. Base of fur everywhere ashy gray; above, black and white most intimately mixed so as to produce the effect of a whitish reflection from black fur, thus resembling a mole. On the sides the white tips are more numerous among the hairs, so that the color is lighter, but the fur is so fine that the pelage would not be called grizzled. Under parts very pure delicate white (soft looking) but sparsely sown with black-tipped hairs. Soles hairy. Tail not distinctly bi-color."

There is a dark ring about the eyes, the white of the lower parts embraces the lips to the nostrils, and the muzzle is hoary. The lip is cleft and the fur about this cleft is long and hangs over like a moustache. The fur is close and dense about the small nasal pads. The insides and rims of the ears are silvery white. The tail is terete and very closely hairy, except at the tip, which is as naked as in *Geomys*, and is gradually reduced

in size from the middle to the apex. The vibrissæ are unusually fine and long, reaching beyond the apex of the ear, and are of uncertain color, really black, but so polished as to appear partly white. The sole is very densely covered with fine close hairs, and there are but four tubercles. The ears vary in length, but seem to be intermediate between the varieties above mentioned.

O. pallidus burrows on the sandy prairies and seems to be largely diurnal in habit. We know little regarding its habits, but, inasmuch as its stomach was found filled with the remains of grass-hoppers and other insects, we are justified in claiming that the suggestion of a largely insectivorous diet offered by the dentition is borne out by actual observation.

The coloration must be influenced by the constant exposure which a chase of diurnal insects makes necessary upon the open plains; and the short and nearly naked tail are suggestive of the fossorial habits.

The following table gives all the details at command concerning the proportions; and as all the measurements were made with great care upon recently killed specimens, may be trusted as thoroughly reliable.*

No.	Nose to anus.	Tail.	Nose to ear.	Nose to eye.	Hind foot.	Fore foot.	Ear.	Sex.
103	4.60	1.45	1.08	0.60	0.90	0.55	0.60	female.
104	4.40	1.35	1.00	0.55	0.90	.....	0.50+	male.
105	3.95	1.50	1.00	0 50	0.80	0.40	.....	male.
114	4.15	1.60	0.92	0.50	0.85	.....	.....	male.
115	5.10	1.60	1.20	0.60	0 90	0.50	.....	male.

GENUS FIBER, CUVIER.

Fiber zibethicus (L.) CUV.

MUSKRAT.

Figs. 12 and 13.

The muskrat is the largest of the mice and is typically arvicoline, differing chiefly in those modifications correlated with its aquatic habits.

The dentition is moderately individualized. The upper incisors are semicircular with plane outer surface. The first

*It should be said that Dr. Merriam, who has examined the types of this species in the National Museum, considers the present variety identical with the type. In this case the published descriptions obviously require revision.

upper molar has an anterior, two interior and two exterior triangles; second molar with an anterior, interior and two exterior triangles; back molar with an anterior, interior, and exterior triangle, and a posterior V-shaped treffle.

The following notes derived from the Bulletin of Denison University, vol. vi, were printed under the title Biological Notes upon Fiber, Geomys and Erethyzon, by C. L. and C. Judson Herrick:

The muskrat, *Fiber zibethicus*, is sufficiently well-known to every one, and yet perhaps few are aware of the extent to which the animal adapts itself to the varying conditions of its environment. One who casually learned to know the water rat in one of our western states might pass many years in Ohio without recognizing the fact that the same animal abounds in Ohio, and under the changed conditions here prevailing adopts an almost wholly different method of life. It would be more accurate to say that in the cold Northwest, with its luxus of small lakes and marshes, the monotonous career of the animal expands in conformity with the greater variety of aquatic stations.

The muskrat is a truly arvicoline rodent, that is, its affinities are with the field mice rather than with the jumping mice (*Hesperomys*) or oriental rats and mice (*Mus*). Though, at first sight, very different from *Arvicola*, the chief differences in *Fiber* are such as are obviously adapted to aquatic habit. The long, laterally flattened, scaly and naked tail, small ears, obliquely set and fringed hind feet with webbed toes are all modifications induced by accommodation to aquatic habit. The dark brown fur is long, with a liberal admixture of long, stiff, glossy hairs of a darker color than the rest. The color and texture varies with the season, and in early summer rats may be found with a curiously tufted or mottled pelage. There are six mammæ and strongly-developed perineal glands which are responsible for the peculiar musky odor implied by the name. The secretion is often used by trappers for the more expensive castoreum in preparing "scent" used in baiting traps.

As already indicated, the habits of the muskrat are subject to considerable variation. Its usual home is a long burrow opening beneath the surface of the water and passing many yards into the bank, terminating in a cosy nest beneath the protecting roots of a tree. It is here that young are reared and from these burrows the entire family may be seen emerging at twilight to engage in swimming races, games of tag and sportive contests upon the surface of the stream. The head and

rudder-like tail alone project above the surface, and the long V-like diverging ripples which are created by the rapid swimmer soon span the entire stream and stand out in bold relief as they catch the sky tints at sunset. In regions not frequented by man or sufficiently protected by trees long run ways may be traced from these burrows into neighboring meadows or wheat fields. The family is large and the appetite is extensive if not critical. Almost anything of a vegetable nature will be tolerated, but the corn-like roots of rushes and the rhizomes of the water lily as well as flag roots are relished. The frantic and grotesque haste with which the rat when disturbed rushes down the runway toward the water, oblivious to any obstacle, is very amusing and sometimes startling, and may have given rise to the stories of fierce onslaughts upon man. Young-man-afraid-of-his-shadow might readily consider himself beset as the excited rat comes crashing down his path regardless of everything but his destination. Nevertheless, there seems to be considerable evidence that old "rogue" rats are decidedly irascible, and a worried mother rat may overstep the bounds of etiquette in defense of her young. The burrowing habits of the rat associate him with the cray-fish and other enemies of canals and dams. Even in the vicinity of a large city like Cincinnati large numbers are annually taken in the canal banks for their skins, which, when in prime condition, bring 15 to 18 cents.

The comparatively simple domicile above described is adequate for the southern states and flowing waters, but in Wisconsin and Minnesota the conditions are very different. Nearly every quarter section has its small lake or pond, and these pools are shallow and mostly filled with weeds. Here the muskrat finds congenial resorts. Even in the bleak prairies the sloughs and ponds fairly swarm with these furry denizens. Here the intense cold of winter freezes all standing water to a depth of over four feet, so that the openings of the summer homes of the rat are sealed for four or five months and he is forced to construct a building suited to the seeming infelicitous and conflicting conditions. The house must extend above water to admit air; it must be deeply buried from the cold; it must connect with the water; it must contain food; the food should be growing or fresh; the house should afford protection from enemies and escape when attacked.

The solution of these problems might tax the ingenuity of the ablest mind, yet nature, by the use of the simplest ma-

terials under the guidance of natural selection, has solved every one. Let us watch the process, and, I doubt not, learn a lesson of skill and patience. The situation is a shallow pool which is destined to freeze nearly solid. It is grown up with rushes and *Nuphar* or spatter dock, two plants which play an important part in the domestic economy of this animal, supply him at once with food and building materials.

In the placid days of early autumn a pair of muskrats may be seen diving to the bottom and tugging and biting at the roots of the rush. After tearing them off, the rat collects four or five of the rushes, say four feet long, and swims with them to a spot selected over the deepest part of the pool. Here they are arranged in parallel order and carefully straightened. Then another mouthful is brought and placed across the first at right angles. The angles are bisected by other clusters until a circular raft is formed sufficiently strong to support the weight of the animal. Now the colony of rats sets at work in earnest. And all day long one or more rats may be seen on the platform apparently eating rushes. Closer inspection shows that they are biting rushes into short lengths to form the "filling" of the structure. The accumulation increases and its weight causes the raft to sink and a new series of long rushes is added. Thus repeatedly until sufficient material has been accumulated to rest on the bottom of the pond. All the previous weeks the rats seemed to make little progress, as the material sank as fast as lifted much above the surface. During the early stages a strong wind may ruin the work of weeks, but the rats are never discouraged.

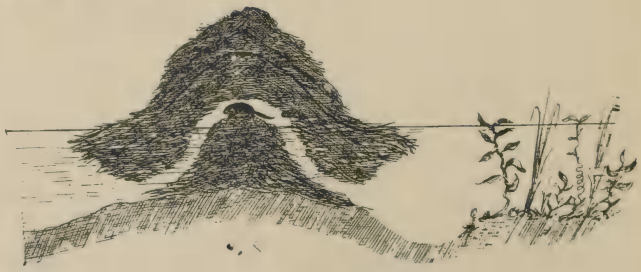

Fig. 12. Section of muskrat hut.

So far only vegetable matter has entered into the composition of the hut, but as soon as it begins to rise permanently above the water there is a change of method and the whole

space about the lodge is cleared of vegetation. The rats dive to the bottom and pull up the rushes and water-lillies by the roots and build them into the structure with large masses of earth adhering. The bottom is deepened and thus the danger of freezing solid is obviated. The earth is used in plastering the outside of the hut, though this is not systematically done. A curious habit we have occasionally observed is the thatching of the hut with the large water-lily leaves so overlapped and cemented with mud as to form an impervious roof. By this time the ice is beginning to form and the hut has settled as much as it will, being buoyed up by the ice. The rats now burrow into the house from near the bottom forming a passage in the form of a letter U inverted, the uppermost part being above the water level and here a small chamber is excavated. Run-ways are excavated beneath the ice to various parts of the pond. In the long excursions undertaken beneath the ice the rats are said to ascend to the ice and exhaust the lungs, permitting the expired air to absorb oxygen and then reinspire it. This we have never been able to observe. The roots of *Nuphar* are built into the house or are stored conveniently near for winter use. The great mass of vegetable matter soon begins to "heat," generating warmth enough not only to add to the comfort of the occupants of this curious home, but to cause new sprouts to spring from the roots. The chamber is enlarged during the winter and the part removed serves to supply food in case of outside famine. The outer layer of mud freezes solid and forms an adequate defense against the wolves which

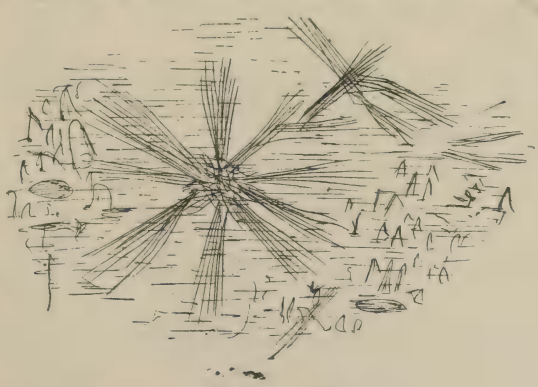

Fig. 13. Muskrat houses.

might otherwise wage a war of extermination. There seems to be a certain reciprocity between the occupants of adjacent lodges, although the rats are jealous by nature and have not the communistic characters of the beaver, though no whit inferior to them as architects.

As to the statement commonly believed by woodcraftsmen in the west that the muskrat prearranges his hut in view of the length and severity of the coming winter we can offer nothing definitely. There is, however, a wide variation in respect to the size and structure of the huts and a general correspondence, though by no means a universal one, between the huts built during a given season. An average hut is 6x10 feet in diameter at the water's edge and the size of the chamber varies from eighteen inches to two feet.

It is interesting to note in this connection the curious statement of Carver as to the winter habits of this animal (p. 425 Carvers Travels.)

"The muskrat is so termed for the exquisite musk which it affords. It appears to be a diminutive of the beaver, being endowed with all the properties of that sagacious animal, and wants nothing but size and strength, being not much bigger than a large rat of the Norway breed, to rival the creature it so much resembles.

"Like the beaver it builds itself a cabin, but of less perfect construction, and takes up its abode near the side of some piece of water. In the spring they leave their retreats, and in pairs subsist on leaves and roots till the summer comes on, when they feed on strawberries, raspberries and such other fruits as they can reach. At the approach of winter they separate, when each takes up its lodging apart by itself in some hollow of a tree, where they remain quite unprovided with food, and there is the greatest reason to believe, subsist without any till the return of spring."

The feats performed by muskrats in opening and devouring mussels may be, as claimed by some observers mythical but there seems to be no doubt that they avail themselves of animal food upon occasion.

"Just before night we saw a *musquash*, the only one we saw in this voyage. The Indian, wishing to get one to eat, hushed us, saying, 'stop, me call 'em'; and sitting flat on the bank, he began to make a curious squeaking, wiry sound with his lips, exerting himself considerably. * * * It was evident that he was in the habit of calling the musquash to him, as he said.

An acquaintance of mine after this tells me that his Indian, in this way repeatedly called the musquash within reach of his paddle in the moonlight, and struck at them."—Thoreau. *The Maine Woods, p. 211.*

Family DIPODIDÆ.

This is an interesting, though not a large, family containing five genera of springing mice distributed over widely separated regions of the earth. The three subdivisions included under this head are so diverse that there is considerable difference of opinion as to their relative rank. The affinities assumed for the animals included in them are borne out by external resemblances more fully than by anatomical structure. Alston gives the following diagnosis of the family: "Incisors compressed. Premolars present or absent. Grinding teeth rooted or rootless, not tuberculate, with more or fewer transverse enamel-folds. Skull with the brain-case short and broad, infraorbital opening rounded (often as large as the orbit); zygomatic arch slender; curved downward; the malar ascending in front to the lachrymal in a flattened perpendicular plate; facial surface of the maxillaries minutely perforated; mastoid portion of the auditory bullæ usually greatly developed. Metatarsal bones greatly elongated, often fused into a cannon-bone. Form slender; front portion of the body and fore limbs very small; hind limbs long and strong, with from three to five digits; tail long, hairy."

Three subfamilies, viz: *(Jaculinæ=)* 1. *Zapodinæ*, 2. *Dipodinæ*, and 3. *Pedetinæ*. The last named departs most from the murine or mouse-like character, and contains a single genus and species found in South Africa. The animal is figured at the left in the headpiece to *Rodentia*. It is of nearly the size of a rabbit, and but for the long and densely hairy tail, would much resemble one. The fore feet are rather larger than those of allied forms, while the nails upon the posterior extremities are almost hoofs. The cervical vertebræ are free as are the metatarsals.

The *Dipodinæ* form three genera, *Dipus*, *Alactaga* and *Platycercomys*.

The first named genus contains the jumping mice of Europe and northern Africa, while the second inhabits the steppes of Asia and European Russia. These animals have the cervicals

more or less anchylosed, and the metatarsals fused to form a so-called cannon-bone. The tail is long and tufted at the end. Lastly we come to the

Subfamily ZAPODINÆ.

One species is the sole representative of this group, which by Coues is made a distinct family. This species ranges over a considerable portion of North America, and has been quite elaborately discussed by recent authors, so that we may simply note the characters of the subfamily before passing to the description of the animal itself :

Dental formula: $\frac{1}{1}:\frac{0}{0}:\frac{1}{1}:\frac{3}{3}=18$. Upper incisors compressed, sulcate ; molars rooted. Head short and rounded. Anteorbital foramen large. Malar bone produced anteriorly, uniting with the lachrymal. The zygoma is slender and depressed. Fore feet small; hind feet enlarged, but normal. Tail very long but not tufted.

Genus ZAPUS, Coues.

Zapus hudsonius (Zimmerman) Coues.

This jumping mouse is perhaps the most interesting of our Minnesota rodents. The greatly elongated foot in which, nevertheless, the bones are all distinct, the long tail, greatly exceeding the body, the enormous ears with valvular flaps, and the cheek pouches constitute unique characters.

The average length is 3 inches, tail 5 inches, hind foot 1.18 inches. The hinder parts of the body are enlarged, while the truncate muzzle gives the profile a peculiar appearance. The pelage is coarse and the tail is like that of the common mouse. The color above is of a rather intense yellowish cast with a brownish dorsally; pencilings of brownish-black due to the elongated hairs shade the back. The under parts are beautifully white, sharply set off from the coloration of the back. The species has only been observed by the writer in the western part of the state. At Lake Traverse it was found in a state of primitive simplicity, and was readily taken in the hand.

An article in the *American Naturalist* for June, 1872, by Sanborn Tenney, affords the following facts regarding the hibernation of the *Zapus*:

"On the 18th of January of the present year (1872), I went with Dr. A. Patton, of Vincennes, Indiana, to visit a mound situated about a mile or a mile and a-half in an easterly direction from Vincennes. While digging in the mound in search of relics that might throw light upon its origin and history, we came to a nest about two feet below the surface of the ground, carefully made of bits of grass, and in this nest was a jumping mouse *(Jaculus hudsonius* Bd.*)* apparently dead. It was coiled up as tightly as it could be, the nose being placed upon the belly, and the long tail coiled around the ball-like form which the animal had assumed. I took the little mouse into my hand. It exhibited no motion or sign of life. Its eyes and mouth were shut tight, and its little fore feet were shut and placed close together. Everything indicated that the mouse was perfectly dead, excepting the fact that it was not as rigid as perhaps a dead mouse would be in the winter. I tied the mouse and nest in my handkerchief and carried them to Vincennes. Arriving at Dr. Patton's office I untied my treasures and took out the mouse and held it for some time in my hand. It still showed no signs of life; but, at length I thought I saw a very slight movement in one of the hind legs. Presently there was a very slight movement of the head, yet so feeble that one could hardly be sure it was real. Then there came to be some evidence of breathing, and a slight pressure of my fingers upon the tail near the body was followed by an immediate but feeble movement of one of the hind legs At length there was unmistakable evidence that the animal was breathing, but the breathing was a labored action, and seemingly performed with great difficulty. As the mouse became warmer the signs of life became more and more marked; and in the course of the same afternoon on which I brought it into the warm room it became perfectly active, and was as ready to jump about as any other member of its species. I put this mouse in a little tin box with holes in the cover, and took him with me in my journeyings, taking care to put in the box a portion of an ear of corn and pieces of paper. It ate the corn by gnawing from the outside of the kernel, and it gnawed the paper into bits with which it made a nest. * * * On the evening of February 6th I reached my home in Williamstown, and on my arrival the mouse was in good condition; but the next morning it was again apparently dead. In the course of the day, however, being placed where it was warm, it gradually came back to activity as before."

"Mr. Slade says*: 'The long-tailed jumping mouse inhabits high land or low land, forest or pasture, cultivated field or swamp, and appears to be equally at home in either, and numerous in any situation. It possesses a momentary agility second to no other rodent, and a muscular strength of enormous power for so small a creature. When suddenly disturbed it often moves away in a direct line, the first three or four leaps being eight or ten feet in length; but these distances rapidly decline to about four feet, which are continued until it considers itself out of danger. This is not always the case for it frequently takes an irregular course and jumps at diverse angles for several successive leaps. * * * It feeds upon the buds, leaves and twigs of many kinds of plants, upon seeds, grain, wild berries, chestnuts, acorns, grass, and to some extent, upon the bark of shrubs. * * * As a rule, three litters are produced in a season, each consisting of from two to four young."

Family GEOMYIDÆ.

POUCHED OR POCKET-GOPHERS.

The pouched rats are among the most interesting and peculiar of North American mammals and from their secluded habits are seldom seen. They have, however, considerable economic importance, as their insidious and undisturbed forays upon gardens and orchards render them more obnoxious than more open foes. From their habits unlikely to spread rapidly, they multiply in favorable localities to an incredible extent and miles of meadow land are honeycombed by their burrows. For the same reason they are somewhat arbitrarily distributed.

From the fact that the few species are so similar, and closely allied geographical races so numerous, it might be inferred that the group, as at present found, is of a comparatively recent origin and that its different members are diverging from a common centre west of the Mississippi. To this it might be replied that subterranean, like subaqueous, species are subject to slower changes than those more directly influenced by climate, etc. However this may be, the family is distributed over the western part of the United States and ranges southward into Mexico. The eastward range is little beyond the states

*Merriam's Mammals of the Adirondacks, p. 292.

bordering upon the Mississippi river except southwardly, where a variety of our common *Geomys bursarius* extends into Florida and Georgia and was the first of the family found in the United States though a different species was previously noticed in Mexico. The northern limits of the family are determined by the frosts of winter, for burrowing becomes an arduous task where much of the time the soil is frozen six or more feet deep.

In the New England and Middle States the family is entirely absent.

These low-bodied, dense-furred animals are chiefly remarkable for the large fur lined pockets extending from the shoulder to the sides of the mouth and opening entirely outside the buccal cavity. The pockets have several special muscles to retain them in place. The pockets are used for carrying food, which in all the species, is stored in subterranean graneries against time of drought or winter frosts. Considerable skill is shown in collecting the proper amount in one place, so that the heat generated in a mass of grass, for example, shall be enough to cause the growth of fresh shoots but not enough to destroy the whole.

As now understood the pocket-gophers constitute a well circumscribed family of two genera, allied, on the one hand, to the field mice (*Arvicolidæ*) by many important cranial and other characters and, on the other to the pouched mice (*Saccomyidæ*) by the possession of fur-lined pouches on either side of the mouth (but having no connection with the mucous surfaces). Again, the gophers are allied by quite unmistakable points of agreement with the African mole rats (*Georychidæ*) which in habits they more resemble than either of the above families. If it were pertinent in such a work as this to discuss the relative value of these different affinities, it might be shown that a very good case could be made in favor of a closer relationship with the *Georychidæ* or *Muridæ* than with the *Saccomyidæ*. After a comparison of cranial characters between *Fiber* the *Saccomyidæ* and *Geomys* it seems well to suggest that the presence or absence of external pockets ought not to be too implicitly relied upon in collocating the families of rodents.

It is only safe to say at present that the *Geomyidæ* constitute a distinct family of myomorphic rodents with uncertain interordinal affinities. No definition of the family is necessary in this connection, but the student is referred to the following papers on the group :

COUES, E., Monographs of N. A. Rodentia, Geomyidæ.
COUES, E., do Saccomyidæ (Introduction—*passim*).
COUES, E., Exploration of Colorado river, Part iii, Chapter xii—Abtract of results of a study of the genera Geomys and Thomomys.
COUES, E., The cranial and dental characters of Geomyidæ. From the Bull. U. S. Geol. and Geogr. Surv., 1875.
LICHTENSTEIN, K. W. H., Ueber aeussere Backentashen on Nagethieren. Koengl. Akad. Wiss. Berlin, 1825.

The chief characteristics of the family may also be gathered from what is said of the one species which comes especially under consideration here.

GENUS GEOMYS, RAF.

This genus contains four species which occupy a belt through the center of the United States from British America to Central America. It does not extend beyond the Rocky mountains on the west, nor reach the Atlantic coast except southwardly.

As distinguished from *Thomomys*, *Geomys* possesses the following characters: The upper incisors have a deep median groove which may be accompanied by a second fainter one near the inner margin. The inferior incisor is very long, causing a slight protuberance on the outside of the ascending ramus between the angle and the condyle, but this is not so highly specialized as in *Thomomys*. The crowns of the molars are not acute exteriorly. Zygomatic arch widest in front, not forming a sweeping gradual arch as in *Synaptomys*. The basioccipital is not greatly narrowed. Interparietal triangular. The palatal bone is on two planes with a double excavation between. Fore claws greatly enlarged, claws of hind feet spade-like. The external ears are inconspicuous.

The differences upon which the genera are separated are minute and almost intangible, but on account of the few species of *Thomomys* may be found permanent. The latter genus contains but two species and one of these is a reduced form found only in the unfavorable mountain regions of the west. Indeed, it may be said that the limited size and many of the peculiarities of the genus are perhaps correllated with the range in dry or otherwise ill-suited regions, and are what might have been predicated in the case of a *Geomys* transferred to the same localities.

Of the genus *Geomys* three distinct types occur. The first represented by *G. bursarius* or the common pouched gopher with a southern variety in the south Atlantic and Gulf states (this form, *G. tuza*, is frequently ranked as a species); the second type is that of *G. mexicanus*, which is the Mexican re-

presentative of the genus. Aside from the size, which is greater than *G. bursarius*, there is the absence of the marginal groove on the incisors, the reduced fore-claws and pouches to distinguish this type. With it is associated another "species" (*G. castanops*) found only in Texas and New Mexico, and which combines with the characters of the one some of those of the other. The third type occurs in Central America and and is represented by the single species *G. hispidus*. The tendency exhibited in the Mexican species is here extended. The result is an animal nearly a foot long with shallow pockets, stiff, hairy fur and short claws.

Geomys bursarius (SHAW) RICHARDSON.

COMMON POCKET GOPHER.

Figs. 14, 15, 16.

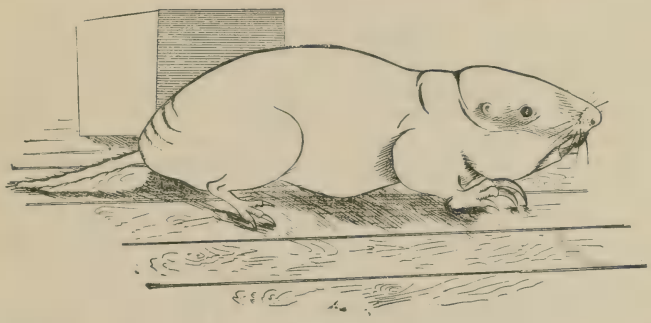

Fig. 14.

The traveler in the states west of the Mississippi river must become familiar with the low mounds scattered over the prairies in groups or irregular series. These mounds are a characteristic feature of the landscape where there is little else to diversify it. They serve to exhibit the nature of the soil and its substratum to the casual observer. These little hills are the masses of earth which are thrown out by the gophers whose burrows mine the soil beneath. The inhabitant of these burrows is the subject of this article. The first description is that of Shaw in the *Linnean Transactions*, v, 1800. The paper was accompanied by a plate which represented the pockets everted and extended, a condition impossible in nature but not

infrequently seen in stuffed specimens. Indeed in so good a work as Owen's Comparative Anatomy the same error is repeated and the gopher is figured with external pouches pendulous from either side the mouth.

The following is as complete a list of the bibliography as I can compile. Much of it is copied directly from Coues' monograph.

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GERRARD, Cat. Bones Brit. Mus., 1862.

Fig. 15.

The external appearance of the gopher is not unlike that of a rat but much more "squat" and compact. The head is broad and flat. The strong fore limbs and the huge claws are a prominent feature. The teeth are also large and very conspicuous by the slight development of the lips and cheeks. The posterior part of the body is produced into a truncate cone supported by the elongated pelvis bones. This truncation is quite conspicuous in so much that the tail seems to spring from a special square-topped prominence. The tail itself is comparatively short and is sparsely hairy or quite naked at the tip. The skin of the tail is not scaly, as in *Muridæ*, but delicate and pink-tinted. The attitude when alarmed, especially when forced into strong light is faithfully reproduced in our drawing† and other characteristic attitudes are copied in the outline vignettes accompanying.

The size* varies greatly in a given locality but there is little geographical variation, and as an illustration the measurements of two females are given, the one being from Minneapolis near the eastern part of the state and one from Brown's Valley in the extreme western part.

†The author refers to a plate which was omitted.

*The following table of measurements refers to specimens collected by Dr. C. E. McChesney, near Ft. Sisseton, Dak., and measured in the flesh. The table is extracted from the complete table published by Coues (p. 614 of his monograph of Geomyidæ) as bearing on the question of variation in size in one locality and that near our own station.

The tails are measured from a different point than those measured by the writer, which must be allowed for:

Sex.	Total length.	Length of body.	Length of head.	Length of fore foot.	Length of hind foot.	Longest claw.
Male	12.08	9.00	2.42	.....	.....	1.25
Male	.....	8.00	2.45	.....	.....	1.05
Male	12.07	9.00	2.62	1.80	1.37	0.93
Female	10.30	7.90	2.05	1.60	1.27	0.77
Female	9.80	7.20	2.00	1.47	1.05	0.62
Male	11.46	8.50	2.36	1.66	1.35	0.81
Male	9.07	6.50	2.08	1.50	1.20	0.70
Male	11.12	8.50	2.12	1.64	1.27	0.80
Male	12.38	9.25	2.45	1.70	1.30	0.84
Female	9.98	7.50	2.05	1.60	1.18	0.80
Female	9.45	7.00	1.97	1.46	1.14	0.75
Female	9.80	7.30	1.97	1.55	1.22	0.67
Female	10.12	7.45	1.97	1.60	1.27	0.69
Male	11.65	9.00	2.20	1.82	1.35	0.83
Male	11.30	9.25	2.47	1.78	1.40	0.81
Female	10.75	8.00	2.00	1.63	1.35	0.75
Female	10.61	8.00	2.03	1.60	1.27	0.74
Male	12.02	9.25	2.30	1.85	1.45	0.82
Female	10.67	8.00	2.00	1.68	1.27	0.73
Male	11.25	8.25	2.02	1.69	1.38	0.75
Female	10.33	7.50	1.90	1.57	1.18	0.60
Male	12.11	9.00	2.50	1.76	1.43	0.83
Female	10.62	7.85	2.20	1.68	1.33	0.81
Female	9.79	7.12	2.12	1.55	1.28	0.66
Female	8.25	6.00	1.63	1.37	1.14	0.47
Male	9.18	6.50	1.62	1.55	1.25	0.57
Female	10.91	8.25	2.00	1.65	1.23	0.70
Female	9.92	7.00	1.92	1.64	1.25	0.70
Male	8.63	6.08	2.10	1.55	1.26	0.64
Male	11.53	8.50	2.20	1.82	1.37	0.73

No.	Place.	Sex.	Total length.	Body	Tail	Nose to eye.	Nose to ear.	Lower incisor.	Palm.	Sole	Longest claw.
46	Minneapolis	Female	$10\frac{1}{8}$	$7\frac{1}{4}$	$2\frac{7}{8}$	1	$1\frac{7}{10}$	$\frac{1}{8}$	$1\frac{6}{10}$	$1\frac{4}{10}$	$\frac{7}{10}$
48	Brown's Valley	Female	$10\frac{1}{4}$	$7\frac{1}{8}$	$3\frac{1}{8}$	1	$1\frac{3}{4}$	$\frac{1}{8}$	$1\frac{5}{8}$	$1\frac{5}{16}$	$\frac{3}{4}$

The length of the opening to the pouch is $1\frac{6}{10}$. The fur is dense and very soft, mole like. The under fur is plumbeous and very fine. Externally the color is a subdued but rich brown with a purplish or reddish reflection, and during the life of the animal has a glossy brilliancy not to be seen in the prepared skin. The head and middle of the back are darker brown. Beneath the colors are much lighter, becoming whitish on the feet, tail and lower lip. There is also a light spot on the nose and below the small muffle. The whiskers are thin and pale. In a female in the flesh before me as I write (August) the colors are paler than above described, the prevailing tone

being very light hazel darkened with Vandyke on the back and grayish below. There occurs a peculiar phase of coloration which is not known to correspond to any seasonal or physiological condition, where the animal is dark (almost black) gray and nearly concolor. In aged individuals there is a considerable admixture of white hairs, especially upon the head. In summer the feet and tail become nearly naked.

Fig. 16.

"The habits being entirely subterranean with the exception of rare nocturnal forays, our acquaintance with the animal must necessarily be formed under unfavorable conditions. It is little wonder that when dragged ruthlessly from its home a prisoner in the jaws of a trap, the recluse-like animal produces an unfavorable impression. When thus brought into the blinding glare of the daylight he throws himself back upon his haunches, elevates his head, and, half in fury, half in pain, gnashes his teeth and utters the aspirated sigh-like spit which is the only note of offense. Blinded by the light, he turns toward every sound and appears quite demented. But in the seclusion of his burrow or when once on friendly terms with his captor, he appears a very different creature. Perhaps we are the only persons who have had the opportunity to study the interesting habits of the Geomys in captivity. After a short time he becomes perfectly tame and an engaging pet. When first secured he ate sparingly of potato but evinced decided preference for leaves and rhizomes of red clover, seizing them in one fore paw, which was used as a pair of forceps by bringing the long claws in opposition to the callosity of the palm, and feeding himself gracefully. While eating he assumed a semi-erect attitude and arched the back much as the muskrat does. In eating a

clover plant he always pursued the same method, beginning at one extremity and "feeding it into" the mouth rapidly, and uniformly using now one fore paw, now the other. After the keen edge of the appetite was removed the animal began at once to stow food into his pockets, in doing which he reversed his former position and seemed to all but stand on his head, cramming in the leaves and roots with much celerity. The play of jaws is ordinarily like that of a rat, but at times, when a large root was encountered, the jaws were set in rapid motion so that the clicks made by the teeth blended in one uniform clatter. A similar habit has been noticed in several rodents, especially the porcupine. The only truly vocal sound was a sharp squeak if the hissing note of rage be excepted. Upon the smooth surface of the floor the motions seemed embarrassed and awkward. A small twine stretched on the floor served to stop his course until he divided it with the teeth rather than step over it."

"When placed in a vessel of fresh earth the Geomys seemed almost distraught. The smell of fresh soil acted as a powerful stimulant and the animal careened about before falling to violent digging which he carried on literally tooth and nail, biting the clods, rooting violently, and throwing back the earth with the feet. This, however, was but play, and it was only when given larger quarters that he began the excavation of a burrow in real earnest. The position in digging is with the hind feet well forward and the back strongly arched. The earth is thrown back with the fore paws, and, as it accumulates under the animal, the latter launches a vigorous kick with both hind feet in the most ludicrously earnest manner. After a considerable pile is thus formed behind the animal, he turns about and approximating the callosities of the two fore feet in front and with the claws well up, he pushes the mass before him by the action of the hind limbs until it piles up in front of him, and he looks like a diminutive earth scraper. It is in this way that the earth is brought to the surface and not in the pockets as often stated. The whole process is accomplished in the most brisk and business-like manner possible. Thus, in the habits of the animal we have the explanation of an osteological peculiarity of the wrist. There is a strongly developed bone (the falciform) not found in many mammals which serves to support the callosity which in this case, as we have seen, serves both as a scraper and an aid in prehension. The most noticeable fault of the gopher is his gluttony. The amount he eats

is alarming. Our pet seated himself calmly upon the knee and disposed of one grass stalk after another most vivaciously, eagerly seeking for more. Bread was especially desired and with a shrewd eye for the future the beggar would fill both pockets, and when appetite and both pockets were filled he would empty the latter in a corner of his den and promptly return for more."

"When given the liberty of the room, he set off in a curious canter but usually returned to be placed in the box, where he constructed a new nest every day. In the darkest portion he formed a nest of dry grass where the midday sleep was enjoyed. This siesta is very profound so that one could frequently remove him from the box before he awaked, which he did with a start and appeared to require some time to get his bearings."

"In suitable localities one may trace the progressive extension of the burrow by the small hillocks of earth thrown up, often extending in an irregular line for many rods in a meadow. The digging is chiefly confined to the early summer and autumn, or after a long rain. Dry earth is difficult to manipulate and during drought the favorite food of the gopher is not to be secured. The hillocks resemble those of a mole but are much larger. The burrows are of two sorts, permanent run-ways and explorative or temporary burrows. The latter are near the surface and are closed off from the permanent burrow when completed. When such a burrow is made in a potato field it can be traced with the utmost regularity from hill to hill and the tubers are systematically removed and stored in large deep cellars. The amount which one family will carry off in a few days is all but incredible. The natural food consists of grass roots, especially the tender shoots of the red clover, and like plants. A curious provision against winter needs was frequently observed. The main run-way was provided with blind alleys at intervals, each of which was somewhat expanded at the end. Here a store of grass roots is accummulated in quantities varying from a pint to nearly half a peck. The amount seems to be intentionally limited so that the slight heating shall stimulate the roots to fresh growth, thus providing fresh supplies for the winter. Larger chambers are constructed for the tubers of Helianthus, etc."

"It is probable that the animal does not drink. Current stories as to the digging of subterranean wells and the like being, so far as we could learn, fabrications. There is no evidence of hibernation though in the nature of the case it cannot

be disproven. The female appears to perform most of the work of digging."

"The gophers may be trapped by one familiar with their habits. When a fresh mound is found this should be opened so that direct daylight falls into the burrow. Then a second opening is made along the trend of the passage about eighteen inches from the first. The opening is carried a few inches below the level of the run-way and in it a small steel trap is placed. The trap is carefully covered with light earth to the level with the run-way and the light completely excluded from the second opening. The success of the plan depends upon the dislike of the gopher for light. He at once brings a fresh supply of earth to stop up the opening and being blinded by the light does not observe the second excavation. If the latter presents any irregularities, however, he immediately deposits the load there and barricades the burrow at that point." *

Family LEPORIDÆ.

HARES.

This small and well-defined family is pre-eminently North American and our own state contains parts of two rather distinct faunas, though only three species are as yet known.

The geographical distribution of the family, taken in connection with that of other rodents, is puzzling. South America is richer than any other continent in rodentia and yet the single species of hare found within it is more than probably derived more or less directly from the North American group. More than this, the pikas (*Lagomyidæ*), which seem to be the closest living allies of the hares, were circumpolar in their distribution in comparatively recent times, though now represented by a single American and six Asiatico-European species. On the other hand, it is true that South America contains a variety of curious rodents specialized in different directions. Here, for example, are springing, hare-like animals with long squirrel-like tails, others resembling antelopes in form and possessing hoof-like claws (*Dolichotis*). The Guinea pigs and the hog-like *Hydrochœrus* (capybara) make up with these a curious and suggestive assemblage of forms from among which it may be possible to glean evidences of the common stock from which

*C. L. and C. Judson Herrick. Bul. Denison Univ., vi.

they, with the hares, have descended. The hares are, however, among the most widely distributed of rodents, and with the squirrels are found in most parts of the world, except Australia, the mice being the only family superior in this respect.

Thus far a very few species of fossil hares have been found and these are united in the genus *Palæolagus*, Leidy, and are from the Miocene formations of America. Related species referred at present to the same family have been found in Pliocene and later deposits also in America. The pikas *(Lagomys)* have not yet been found fossil in America, but are known to have inhabited the whole of Europe and England in Pliocene times. The geographical limits of the latter group has thus been greatly reduced meanwhile probably by the more extensive glaciation of Europe.

OSTEOLOGICAL PECULIARITIES OF LEPORIDÆ.

There are long hypapophyses, or ventral median processes upon the anterior lumbar vertebræ. These processes are almost peculiar to the hares. The anterior thoracic vertebræ have very long spines. The transverse processes of the lumbar vertebræ are also very long and, with the hypapophyses, serve to set off the interior muscular masses which play so important a part.

The caudal vertebræ are few and those at the base have a great expansion of the transverse processes.

The manubrium of the sternum is compressed and extended forward as in other rodents in which the clavicle is rudimentary.

The skull has its longitudinal axis more or less strongly curved, the facial surface of the maxilla is perforate and curiously reticulated. The lachrymal bone is entirely within the orbit.

The palate in rodents is usually narrow. In the hare the anterior palatine foramina are longitudinal slits of great size. The part of the palate between the molars is reduced to a very narrow bridge.

The tympanic is anchylosed to the periotic and develops a well marked tubular auditory meatus which is directed upwards and backwards. The supraorbital process forms a great shield over the eye. The hyoid arch is reduced, the basihyal being compressed and keeled.

The scapula is rather slender, the acromium is long, and there is a long metacromium. In the rabbit the clavicle develops

only after birth. An os centrale is found in the carpus. The outer or acetabular border of the ilium is almost obsolete, and the gluteal and iliac surfaces are confluent.

The tibia is very long. There is a third trochanter below the trochanter major of the femur. The fibula is slender and distally united with the tibia, while above, it is united by an interosseus cartilage. The hallux or inner toe is wanting, and the metatarsals are elongated.

COMPARISON OF CRANIA OF AMERICAN HARES.

The skulls of *Lepus callotis* and of *L. californicus* are very similar. *L. californicus* appears to have the mandible more slender, with the margin between angle and condyle more deeply excavated, otherwise the two species agree quite fully and differ from *L. timidus* var. *arcticus* and *L. campestris* in the very long and slender nasals, the less strong curvature of the crani-facial axis and some other differences.

The skulls of *L. aquaticus* and *L. palustris* carry out the peculiarities of the *L. sylvaticus* group to an extreme. The lower jaw becomes solid and broad. The supraorbital frontal processes are fused completely with the skull. The hamular process of the zygomas are enlarged, thus giving greater security to the glenoid fossa. In both, the maxillary part of the inter-alveolary bridge is enlarged rather than the palatal portion. The constriction of the nasals just prior to the end is also noticeable.

The differences between the skulls of *Lepus sylvaticus* and *L. auduboni* are not of a very tangible character,if we may judge from Prof. Baird's figures. The comparison is not facilitated by the fact that the skull of the latter figured was evidently that of a young animal while that of *L. sylvaticus* is an old one with sutures closing and frontal processes united with the skull. (See Baird's Mammals, Pl. lviii.) The interparietal of the latter is either ignored or has anchylosed with the neighboring parts. But we know that usually at least this anchylosis does not take place even in old *L. sylvaticus*. Other apparent differences may, probably, be eliminated in like manner. Baird's figure of the basis cranii in the one case is incomplete but shows the absence of two teeth present in the *L sylvaticus*.

ANATOMY OF SOFT PARTS.

The stomach is roundish, curved, partially constricted into two compartments of which the pyloric is most muscular. The cœcum of the intestine is large.

There are ten teats in *Lepus*.

The external ear varies in size and form with the species, but the following description of that of *L. campestris* will serve to illustrate its peculiarities:

It is in this species of immense size, being 7½ inches long from the base to tip. The essential parts to be distinguished are the cartilage which gives it its form, the muscles and the dermal covering. The ears are densely furred without and half way down within and are thus well protected from the severity of the rigorous climate in winter. The cartilage itself is papery toward the tip but below becomes somewhat thicker. The general form may be described as spoon-shaped, the lower ⅙ being the hollow handle, this part is tubular and forms the opening into the internal ear. Aside from the nearly straight canal formed by the upper part of the tube are two semi-cylindrical cavities, one on either side. The anterior of these is the pars anteriorhelicis which consists of two parts, the anterior being a blind sac ⅜ in. deep—the fossa conchæ—the posterior a groove separated from the meatus by a small spina helicis anterior. A much larger spina helicis posterior separates the other part of the helix which occupies the opposite side of the ear; this groove opens into the external meatus below. At the bottom of the slit which forms the opening of the external ear is a lobate slit called the incisura intertragica which separates two concave lips which represent the tragus and antitragus. The upper part of the ear or scapha is less concave and is well furred. The scutulum is the large cartilage at the base which slides over the top of the skull and furnishes insertion and origin for many muscles which move the ear; it is ⅞ inch long.

Lepus campestris BACHMAN.

PRAIRIE HARE.

Fig. 17.

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This is readily distinguished from any species found in Minnesota, not only by its great size, but by the great length of ears and tail, which latter is white above and below. It is much larger than the varying hare and about equals the Northern *L. timidus*. It is universally called jack-rabbit. The prairie hare is a denizen of the northern part of the plains, claiming kin with the sage-bush and rattle-snake. Its habitat extends from the plains of the Saskatchewan to middle Kansas and Utah. It occurs in Northern California, and Western Minnesota. The species was first described by Lewis and Clarke in 1814, but received its name from Bachman in 1837, and has suffered several vicissitudes since.

In winter this hare is white throughout except the black tips of the ears and traces of yellowish brown upon the top of the head. The fur does not become white to the base, however, the under fur and base of hairs being reddish brown. In summer the upper parts become yellowish gray or brownish There is usually a white fleck in the centre of the forehead and the ears are creamy white below and brown above.

The following measurements will give an idea of the proportions: Length, 20.25; tail, 5.50; fore foot, 2.85; hind foot, 5.75; hight of ear, 4.80. A female purchased in Minneapolis market, January 12, 1884, measured: Length, 22; tail to end of hairs, 7; tail to end of vertebræ, 4.25; nose to eye, 2.37; nose to ear, 3.75; ear, 5.25; fore foot, 3; hind foot 8.9. The

species has been encountered in Minnesota near Big Stone lake, though it, no doubt, ranges over a large part of Southwestern Minnesota. In 1876 the writer secured a specimen at

FIG. 17. Bones of *Lepus campestris*.

Explanation of figures: Fig. 1, skull from above; Fig. 2, skull from side; Fig. 3, lower jaw; Fig. 4, pelvis; Fig. 5, scapula; Fig. 6, axis; Fig. 7, atlas; Fig. 8, pelvis of *Lepus sylvaticus*.

the head waters of the Des Moines river, which is the most eastern authenticated point of capture of which we have been informed.

In Dakota it must still be abundant as large numbers sometimes find their way into city markets.

Lepus sylvaticus BACHMAN.

COMMON RABBIT.

Fig. 17 (8).

VAR. SYLVATICUS.

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VAR. NUTTALLI.

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AUD. and BACH., Quad. N. A., 1851, ii, 272.
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VAR. AUDUBONI.

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Lepus sylvaticus var. aububoni ALLEN, Proc. Bost. Soc. N. H., xvii, 1875, 434; Monog. N. A. Rod., ii, p. 329.

Geographical variation and distribution. As regards the general subject, the present writer can hope to add nothing to the exhaustive elaboration in Allen's memoir, from which the facts respecting the geographical variation outside our own state are taken with no further acknowledgement. The habitat of *L.* (*Sylvilagus*) *sylvaticus* extends from a line north of the isotherm of 45°, but conforming more or less with it, except westerly, where the northern limit is restricted, over the greater part of the United States and southward to Yucatan.

The typical *L. sylvaticus* extends from Southern Maine west to Dakota, south through Nebraska, Kansas, Indian Territory and Eastern Texas to Yucatan. The entire United States east of this line save the hights of the Alleghanies are occupied by this tolerably permament variety. The geographical variation over this region consists in "an increasing paleness from the Mississippi westward toward the plains, where the variety *sylvaticus* passes by insensible steps into variety *nuttalli*. The specimens from Eastern Nebraska and Eastern Dakota can, in general, hardly be referable to the one form rather than the other. At the southward the colors become slightly more intense, but the difference is by no means striking. * * * The brownish terminal band of the under fur becomes more uni-

formly traceable, being generally present in specimens from about Washington, but much stronger in those from S. Carolina and Florida, in which it generally forms a strong, broad bar, though sometimes obsolete."

The amount of black i. e. the length of the black tips of the coarser hairs is variable in the same locality, seasonally and otherwise.

Winter specimens are lighter than the same individuals in summer, and the difference is apparently greatest to the north. Our Minnesota winter specimens are very light colored. Although there seems to be a tendency to a decrease in size southward according to the usual law, it is slight and specimens from Mexico are as large as northern individuals. The local peculiarities of station seem to have a more direct influence than the general geographical influences.

"Southern specimens generally have the ears less covered han northern ones, the feet less heavily furred, and the general pelage harsher and less full. Southern specimens also show a tendency to decidedly longer ears than the northern ones." This is in accordance with the law, an increase of mean annual temperature and humidity tends to cause greater development of apendicular parts.

VAR. NUTTALLI.

This variety expresses the law that treeless, dry regions tend to diminish the intensity of coloring. "The lightest specimens appear to be those from western Wyoming, Colorado, Nevada and Utah, Arizona specimens passing gradually into var. *arizonæ*." In size there is some difference, the present variety being, according to Allen, about twelve per cent. smaller. The proportions are the same and the difference in size has usually been overestimated. Northern specimens have dense soft fur and heavily-clothed ears and feet. The paleness is due to a suppression of the yellowish or fulvous subterminal rather than the black terminal portion of the coloring.

VAR. ARIZONÆ

is the extreme of the tendency expressed by the above but with the addition of considerably elongated ears, they being one-third longer than those of types of the above variety. This variety was founded upon some six specimens, of which part at least were young, and we await with interest the accumulation of additional material.

VAR. AUDUBONI

is about the size of *L. sylvaticus* and has longer ears. The dorsal surface is yellowish-brown mixed with black, underneath white. It is the darker phase of *L. sylvaticus* inhabiting the moist regions of the Pacific coast from northern California to San Diego, passing on the southern limit into var. *arizonæ*. In color it is said to resemble *L. trowbridgei* which is much smaller and has no black upon the ear-tips and has a shorter tail.

The *L. bachmani* described by Waterhouse and figured by Audubon is regarded by Allen as simply the common variety, an immature individual being the basis of the description and figures. The latter are very poor and are not distinctive.

L. artemisia is regarded as a synonym for *L. nuttalli*. The name *L. bachmani* was applied later to the gray hare of the Texas plains and it is therefore doubtful if that name is not also a synonym of the sage hare, *L. nuttalli*.

Size. A full grown female gives the following measurements: Length, 18.50; tail, 3; nose to eye, $1\frac{5}{8}$; nose to ear, (opening) $3\frac{1}{2}$; nose to occiput, 3.25; ears, $2\frac{3}{4}$; fore foot, $1\frac{7}{8}$; hind foot, 4.25. (No. 38, Jan. 1884). This it will be seen from the appended schedule is not an unusual measurement for adult specimens in Minnesota. Out of thirty-five specimens, of which measurements are given in Allen's Monograph of North American Leporidæ, but one reaches the length given above. The wide range from which the specimens were received makes it the more remarkable that that one should be from Iowa, and the next largest (17.00 long) should be from Wisconsin, and that the suit of specimens from Iowa should be uniformly of large size. The average of the thirty-five specimens falls below 15.45. A number of specimens from Kansas fall below 13.50, showing, presumably, a transition to the western varieties.

Of *L. sylvaticus*, Baird gives following measurements of a fresh specimen:

Nose to occiput	3.25
" " eye	1.93
" " ear	3.17
" " root of tail	16.75
" " end of outstretched legs	26.75
Tail to end of vertebræ	2.00
Tail to end of hairs	2.75

Forearm	3.08
Elbow to end of claws	4.75
Tibia	3.42
Heel to claws	3.58
This makes the total length	19.50

Or 1 in. more than our largest specimen.

Lepus americanus Erxl.

VARYING HARE. "WHITE RABBIT."

Var. americanus.

Lepus americanus Erxleben, Syst. Reg. Animal., 1777.
Gmelin, Syst. Nat., i, 1788, 162.
Shaw, Gen. Zoöl. Mam., iii, 1801, 202.
Desmarest, Mammalogie, 1822, 351.
Sabine, Franklin's First Journ., 1824.
Richardson, App. Parry's Second Voyage, 1825, 324.
—— Fauna. Bor. Am., i, 1829, 217.
—— Back's, Arct. Land Exp., 1836.
Fischer, Syn. Mam., 1829, 376.
Bachman, Journ. Acad. Nat. Sci. Phila., vii, 1837, 403; viii, 1839, 76.
DeKay, New York Zoöl., i, 1842, 95.
Wagner, Suppl. Schreber's Säuget., iv, 1844.
Waterhouse, Nat. Hist. Mam., ii, 1848.
Audubon and Bachman, Quad. N. A., i, 1849.
Giebel, Säugethiere, 1855, 449.
Baird, Mam. N. A., 1857.
Gray, Ann. and Mag. Nat. Hist., 3d series, xx, 1867.
Maximilian, Wiegm. Archives, 1861.
Ross, Canad. Nat. and Geol., vi, 1867.
Welch, Proc. Zoöl. Soc. London, 1869.
Gilpin, Proc. and Trans. Nova Scotia Inst. Nat. Sci., iii, 1872.
Lepus hudsonius Pallas, Nov. Sp. Glires, 1778.
Boddært, Elench. Anim., i, 1784.
Zimmerman, Pennant's Arktische Zoöl., i, 1887, 96.
Lepus nanus Schreber, Säuget., ii, 1792.
Lepus campestris Hayden, Am. Nat., iii, 1869.
Dall, Alaska and its Resources.
Lepus variabilis var. Godman, Am. Nat. Hist., ii, 1826.
Lepus borealis Schintz, Synop. Mam., ii, 1845.
Lepus americanus var. americanus Allen, Monog. N. A. Rodentia, 1876.
"*American Hare*," Forster, Pennant, Etc.

VAR. VIRGINIANUS.

Lepus americanus BACHMAN, Journ. Acad. Nat. Sci. Phila., vii, 1837; viii, 1839.
DEKAY, WAGNER, AUD. and BACH., BAIRD, GRAY.
ALLEN, Bull. Mus. Comp. Zoöl., i, 1869.
HALL, Can. Nat. and Geol., vi, 1861.
Lepus virginianus HARLAN, Fauna Am., 1825.
FISCHER, Synop., 1829.
DOUGHTY, Doughty's Cab. N. Hist., i, 1830.
BACHMAN, Jour. Acad. Nat. Sci. Phila., vii, 1837.
EMMONS, Quad. Mass., 1840.
THOMPSON, Nat. Hist. Vermont, 1842.
Lepus americanus var. virginianus ALLEN, Monog. N. A. Rodentia, 1876.

VAR. WASHINGTONI.

Lepus washingtoni BAIRD, Proc. Acad. Nat. Sci. Phila., vii, 1855; Mam. N A., 1857.
COOPER, SUCKLEY, SUCKLEY and GIBBS, Pacif. R. R. Reports, 1860.
GRAY, Ann. and Mag. N. H., 3d ser. xx, 1867.
Lepus americanus var. washingtoni ALLEN, Proc. Bost. Soc. Nat. Hist., xvii, 1875; Monog. N. A. Rodentia, 1876.

VAR. BAIRDI.

Lepus bairdi HAYDEN, Am. Nat., iii, 1869.
Lepus americanus var. bairdi ALLEN, Bull. Essex. Inst., vi, 1874; Proc. Bost. Soc. Nat. Hist., xvii, 1875; Monog. N. A. Rodentia, 1876.

Although I have copied the synonomy for the several varieties of our common hare as given by Allen it must be admitted that, save as to the last, it requires hair (hare) splitting nicety to make out any distinctions which will not be utterly invalidated by individual variation. In general the southern *L. americanus* has a less reddish cast of the summer pelage and the part of the hairs which becomes white in winter is restricted. The period during which the winter pelage is worn is shorter, but the variations in size are so insignificant as compared with individual variation as to present no basis for remark. There is, of course, the probability that the ultimate size of the northern specimens will be found greater, but the facts thus far collected give but negative results. Variety *americanus* in its typical form does not enter the United States so far as known.

The var. *washingtoni*, though originally supposed to be much smaller appears to be simply a more fulvous form with the pelage soft and full. Though this variety is said not to undergo a seasonal change about Puget's Sound, its pelage seems elsewhere to have a deeper outer white zone in winter than the previous varieties.

Var. *bairdi* is not different in size and proportions from other varieties of *L. americanus*. "The most prominent distinctive features in summer pelage are its pure white under-fur, the long, black tips of the hairs and the white feet, and in winter the tendency of the pelage to become pure white to the base." "This variety appears to be strictly an alpine form inhabiting the snowy summits of the higher portions of the Rocky Mountains." Baird supposed that there were marked differences in size especially of the tarsi to distinguish this from the other varieties which are said by Allen not to obtain.

The following remarks must be understood to pertain to Minnesota specimens simply unless otherwise stated:

It is unnecessary to devote space to a description of the habits of so familiar an animal. Chapters of every country boy's experience could easily be recalled by allusions to box-traps and snares. The greatest feat of the creature is performed with his feet, and the image of personified fear with a puff of feathery tail and a confused mixture of hurtling legs and pendant ears constitutes our idea of the hare. Its whole life is one continual flight. Nevertheless there are quiet intervals when fragrant clover blooms and aromatic apple bark sooth the fears. Although so timid, the hare actually possesses considerable courage. A countryman having captured a leveret, was employed in marking it by notching its ears, when he was interrupted by the mother, who flew at him with singular courage and struck so fiercely with her fore feet that she tore his hands severely. Being unable to release her young, she waited until he liberated the little hare, with which she went off. The males are quite pugnacious, waging fierce combats with their own species. Billings gives an illustration in the case of specimens confined with hares of other species. "The old males at this period seemed to be animated with new courage; they had previously suffered themselves to be chased and worried by the common English rabbit, and even retreated from the attacks of the gray rabbit, but now they stood their ground, and engaged in fierce combats with the other prisoners and generally came off victorious. They stamped with their feet and used their teeth and claws, and in the fight tore off patches of skin and mutilated the ears of their former persecutors until they were left in undisturbed possession of the premises." When frightened the rabbit will frequently strike the ground with such force with its feet as to produce a considerable

sound, thus giving the alarm to the does much as the beaver does with its tail.

The hare when close-pressed will take to water, concealing itself in the herbage with only the nose exposed; it also swims readily. Frequently these animals become a great pest, as they peel and so destroy the young fruit-trees. This may be in a measure prevented by painting the bark with tobacco decoction or other distasteful substance. The young of the hare are able to see at birth. The leverets are suckled about three weeks, while the natural life-time is perhaps ten years.

Family HYSTRICIDÆ.

Fig. 18, *Sphingurus villosus* WATERHOUSE, S. Amer.

The porcupines (carefully to be distinguished from hedgehogs) constitute a small family of rather large, clumsy and indolent rodents which are conspicuous among their fellows for the remarkable change which some of the long hairs undergo. These become altered to form sharp quills which usually are so armed with retrorse bristles as to make them very perfect defensive weapons. The body is usually heavy and low, the head short and blunt with heavy muzzle and small ears. The form varies much and, in particular, the tail may be short and bristly, or long, naked and prehensile. The feet have naked soles and usually have the first digit reduced on one or both pairs of limbs. The toes are usually armed with very strong curved claws. The eastern porcupines are terrestrial, living in burrows or cavities in rocks while on the western continent they are more or less arboreal. The food consists of roots, fruits, bark, green leaves and pulpy stalks and, on occasion, almost anything edible. Like most vegetable feeders they are very fond of salt and are as a result of their filthy habits, particularly liable to internal parasites.

The nasals are frequently very large; the lachrymal obsolescent; there is no preorbital process of the temporal as in hares; the zygomas are massive and short. There are four molars in each jaw of similar form and size; the incisors are large and smooth in front; the palate is excised between the molars. Malar bone with no angular process below. There are seven cervical, fourteen to sixteen dorsal, five lumbar, three or four sacral and from twelve to thirty caudal vertebræ. The clavicles are poorly developed. There are but four mammæ in the female.

The porcupines are brought into relation with rodents in general by a number of South American animals which combine the spiny armature with rat-like or hare-like characters.

The family is very naturally divided into two groups or subfamilies as well by the diversity in habits as anatomical differences of the animals inhabiting the two hemispheres. The *Hystricinæ*, or Old World porcupines, are terrestrial and a number of anatomical peculiarities growing out of this habit are observable. The *Synetherinæ*, or American porcupines, are arboreal and thus require more perfect clavicles and ordinarily prehensile tails. The molars are rooted while the number of toes is less, the digits being armed with hooked claws which serve in climbing. The soles are tuberculated or roughened. The

North American species are, as might be expected, more like the European types than those of South America.

As we have but a single species in North America, instead of a more extended discussion of the group it must suffice to give a list of the described species and the above figure of one of the most remarkable of the foreign types.

SUBFAMILY SYNETHERINÆ

Clavicles perfect; molars rooted; toes 4-4 or 5-4; tail generally prehensile; habit, arboreal. Western Hemisphere.

Genus *Chætomys* GRAY. Containing a single species of rather slender form, with a rat-like scaly tail. The malar bone is very broad, with a spur above. *C. subspinosus* Gray, S. A.

Genus *Synetheres* F. CUVIER. The body is rather slender, clothed with straight spines. The tail is scaly at the end only. The temporal region is very broad and high. The body is covered with spines except beneath, where they are replaced by bristles. The skull is greatly elevated between the eyes.

1. *S. prehensilis* BRANDT, S. A.
2. *S. platycentrotus* BRANDT, S. A.
? 3. *S. magna* LUND. } Fossils from Caverns of
? 4. *S. dubia* LUND. } Minas Geraes.
? 5. *S. fossilis* LUND. }

Genus *Sphingurus* F. CUVIER. Much as above but hairy below and without the great elevation between the eyes.

1. *S. villosus* WATERHOUSE, S. A.
2. *S. pallidus* WATERHOUSE, S. A.
3. *S. melanurus* WATTERER, S. A.
4. *S. bicolor* TSCHUDI, S. A.
5. *S. novæ-hispaniæ* WATERHOUSE, Mexico.

Genus *Erethizon* F. CUVIER. (See beyond).

1. *E. dorsatus* CUVIER, N. A.
2. *E. dorsatus* var. *epixanthus* BRANDT.

SUBFAMILY HYSTRICINÆ.

Clavicles imperfect; toes, 5-5; molars but partly rooted; tail, short; habit, terrestrial or fossorial. Eastern Hemisphere.

Genus *Hystrix* LINN. Body short; head thick with blunt muzzle; covered with very long erectile spines; tail inconspicuous.

1. *H. cristata* L., Europe and N. Africa.
2. *H. hirsutirostris* BRANDT, Syria, etc.
3. *H. africæ-australis* PETERS, S. Africa.
4. *H. javanica* CUVIER, Java, etc.
5. *H. hodgsoni* GRAY.

Genus *Atherura* M. G. CUVIER. Much as in *Hystrix*, but with long appendaged tail and but four toes in front.

1. *A. fasciculata* SHAW, Siam.
2. *A. macroura* WATERHOUSE, Sumatra.
3. *A. africana* GRAY, Sierra Leona.

A number of fossil forms of more or less uncertain position might be here included.

Genus Erethizon F. Cuvier.

This genus may be distinguished from other American porcupines at once by its having five toes armed with strong claws behind. The body is thick and bulky, the limbs being short and oddly shaped, adapted for climbing and hanging. The tail is short and covered all over with spines and bristles. The anatomical details are given beyond and it may be simply noticed that the facial part of the skull is greatly elevated and the malars are expanded anteriorly. The molars converge anteriorly; the bullæ are very large and inflated, the infraorbital foramina are of great size. The palate is ridged and ends opposite the third molar. Although there is but a single species, two marked geographical varieties are known, the first of these, the Canada porcupine, once ranged over all suitable woody districts from the Atlantic westward to the Saskatchewan and southward into Virginia. Northward it is restricted by food supply rather than the rigors of the climate and seems to be co-extensive in its range with the timber belt. Toward the west it does not extend so far south as eastwardly and occurred in Ohio, Northern Michigan and Wisconsin and Northern Minnesota. Although well protected from the attacks of wild animals, the porcupine falls an easy victim to man and has neither the skill nor means to evade him. Thus it is that the species is rapidly becoming extinct in settled parts of the country. The western variety extends from the Pacific to meet the Canada porcupine and southward along the mountains to the Mexican line.

Erethizon dorsatus L.

CANADA PORCUPINE.

This animal seems to be less common within the limits of our state than in portions of Wisconsin. Lumbermen of experience state that upon the Chippewa river it is a frequent and annoying visitor to the lumber camps, where its swine-like inquisitiveness leads it to break open and destroy provisions which it can not eat. In Minnesota its distribution may roughly correspond with that of the pine forests, yet nowhere does it become more than locally frequent and, even where measureably common, it is less frequently encountered than

Plate VII.

ERETHIZON DORSATUS. CANADA PORCUPINE.

would be naturally expected from its clumsy habit and sluggish nature. Our own personal acquaintance with the animal is confined to the period of a visit to the St. Louis river in June and July. There upon the northern limits of pinery cutting it may be seen at its best and is at home in the fullest sense. It may be best to introduce the animal to the reader in the same way that we formed its acquaintance. Imagine, then, a few hours before midnight, a birch canoe, with a flaming torch in the bow, propelled quietly down the stream in the shadow of the banks which are themselves brightly illuminated for some distance ahead by our light. We are watching for the luminous eyes of the deer, which, startled in their feeding places stand quaking at the sudden apparition. Our attention is attracted by a most peculiar clattering sound—evidently the teeth of some animal in very rapid motion, but more rapid and louder than anything we had ever heard. The source of the sound we are at first unable to make out, but again we start at the sound of heavy feet and crackling branches. Some heavy animal comes down to the water's edge where the banks are covered with a new growth of arrow-head leaf (*Sagittaria*) succulent and green, for it is June and the receding waters have but lately exposed the roots to the sun. The clatter of teeth is again heard very loud and inexplicable until we make out the gray form of a burly porcupine which at once starts up the bank much as an overfed hog might do. A shot brought the animal to the water's edge where, after floundering about a little, it began to swim toward us evidently in a vindictive mood. Another shot made it ours and we found it an imense animal measuring over three feet from its blunt muzzle to the end of the spiny tail. The stomach of this specimen, a full-grown male, contained nothing but the finely comminuted shoots of *Sagittaria*. On the same night at about eleven o'clock we encountered a second individual which after receiving a shot clambered with comparative agility into the top of a tall tree.

It should not be concluded from the above account that the porcupine is strictly nocturnal. In the afternoon they may be seen feeding along the meadows, using their four-clawed hands with awkward cleverness in bringing branches or grass tufts within reach of their mouths. If alarmed they clamber under the overhanging banks, or under roots of upturned trees, drawing the body together with the quills bristling, and there lie in fancied security. Indeed, in such a position they are more

difficult for the predacious animals which might attempt their capture than ever was chestnut to the inquisitive squirrel. Under ordinary circumstances the larger animals do not attempt to capture the porcupine, but during severe weather game becomes so scarce that the lynx and panther are driven to sacrifice future happiness to the urgent need of food. The porcupine makes a famous dish when once safely "peeled," but sight and even life itself is endangered in the process.

We have received specimens of *Lynx rufus* with the head filled with quills, some of which penetrated the orbit. Such specimens are usually lean and apparently in a famished condition. Even the panther is sometimes found killed by the shafts of this critic among beasts.

Of course there is no truth in the current belief that the porcupine discharges its quills like a horrible animated gattling gun, but it is said that by sudden lashings of its short tail quills are fastened in the skin of its enemies. Once fastened, these barbed quills penetrate with fearful pertinacity, every movement of the body serving to drive them on.

It is not generally known that this animal is a good swimmer. He even voluntarily crosses large rivers and, on account of the lightness of the body, stands so far above the surface as to appear like a very large animal.

Although preferring the green inner bark of trees and new shoots or succulent vegetable matter the porcupine is upon occasion omnivorous. The taste of salt is greatly relished, and pork skins and salt covered barrels are greedily eaten; even the slight salty taste imparted by the hands attracts them, and the implements of lumbermen suffer from their teeth. Indians regard them, in their turn, as delicate food, but what the flavor may be the writer has not ventured to discover.

Of the winter or breeding habits we can say nothing from personal observation. It is said by trustworthy witnesses that during the very coldest weather porcupines sometimes spend days and weeks suspended in the tops of high trees apparently in a state of suspended animation.

It is stated that two young are produced at a birth (more rarely three or four) and these are lodged in hollow trees or like retreats until able to care for themselves. When startled by the approach of man, they are said to utter cries like those of a child.

The porcupine makes its nest in a ledge of rocks or in a hollow log. Its young, which are but one or two in number,

are born about the first of May and are very large, being actually larger and relatively more than thirty times larger than the young of the black bear at birth. Merriam says: "May 1st, 1882, I shot at Big Moose Lake, a female porcupine which contained a fœtus that would certainly have been born within two or three days. It weighed one and one-quarter pounds avoirdupois (567 grammes), and measured in total length eleven and one-fourth inches (285 mm.), the head and body measuring about seven and three-fourths inches (just 195 mm.). It was densely covered with long black hair, and the quills on its back measured over half an inch (13 mm.) in length. The discoid placenta measured two and one-quarter inches (57 mm.) in diameter."

The first mention of the porcupine which I have found in works treating of animals from Minnesota is the following from Carver's Travels (p. 423) which, while rather more accurate than most of his descriptions, contains several errors:

"The body is covered with hair of a dark brown, about four inches long, a great part of which are of the thickness of a straw and are termed quills. These are white with black points, hollow and very strong, especially those of the back. The quills serve this creature for offensive and defensive weapons, which he darts out at his enemies and if they pierce the flesh in the least degree, they will sink quite into it, and are not to be extracted without incision. The Indians use them for boring their ears and noses to insert their pendants, and also by way of ornament to their stockings, hair, etc., besides which they greatly esteem their flesh."

Carver also enumerates the "hedgehog", but does not describe or again mention it. What may be meant I am at a loss to conjecture.

The following measurements indicate the size of a full-grown male: Nose to anus, 2 ft.; girth, 2.4; tail, 11 in.; hind foot, 4.3; longest claw of hind foot, 1.1; claw of pollex, 0.7; longest claw of fore foot, 1.1; tibia, 6; fore leg, 5; upper incisor, 0.9; lower incisor, 1.2; nose to eye, 1.9; nose to ear, 3.7; width of muzzle over 2; hight of muzzle from end of upper incisor, 2.2; eye, 0.5.

The general color is vandyke brown, the quills being yellowish white with brown points. The long hairs, white with dark bands. The outer part of the fur is lighter brown. There is a light stripe on either side the tail, but below it is nearly black

The phalangial part of the feet is umber brown, the nails brownish black.

The full grown female is smaller, and the colors are lighter about the head and shoulders. Nose to anus, 1.8 ft.; tail, 9in; nose to eye, 1.7; nose to ear, 3.6; hight of ear, 1.5; breadth of muzzle, 1.3; longest hind claw, 1.2; longest fore claw, 1. There are four teats, the first pair being five inches from the clavicles, the second seven and one-half. There is a minute claw upon the rudimentary thumb.

A young porcupine collected July 3d, measured as follows: Body, 1 ft., 3.25in.; tail, 6.25; longest claw, 0.7; upper incisors, 0.4. The color is vandyke brown, in which is a plentiful sprinkling of longer hairs, the outer one-fourth of which are nearly white. This gives the whole an ashy appearance unlike the more marked coloration of the adult. There is a girdle of elongated quills forming a zone over the back in front of the pelvic region. In front of this tuft the quills are hidden by the pelage, and back of it the fur is denser and darker, and without the gray hairs except on the sides where also the quills appear. The tail and rump are therefore uniform brown. The under parts of the body are rather sparsely covered with fine hair like that of the raccoon. The tail is nearly black below. The length of the quills of the porcupine varies much. Sometimes they are nearly hidden under the pelage, and at others form a very conspicuous thicket, especially upon the middle of the back and on the hips. There is a prominent tuft of long hairs springing from the back of the head.

Although skeletons were carefully prepared, a subsequent illness afforded opportunity for their misplacement, and I can only give details of the skull and such notes upon the anatomy as were jotted down in the field.

The skull, (see plate VII) when viewed from the side, at once draws attention to the elevation anteriorly. Although a plane touching the condyles and the incisors, also touches the anterior molars, the distance from the end of the incisors to the nasals is nearly 1.50, while from the condyles to the top of the occipital is but 0.90. The zygomatic width is 2.60, the greatest length 3.50. The nasals along the median line measure 1; the frontals the same. The inter-orbital distance is 1.05; the combined width of the nasals 0.75. The distance from the frontals to back of skull is 1.40; from meatus to meatus 1.60. The nasals are spatulate convex; the temporals concave, especially behind. From the rudimentary supraorbital process there

extends a prominent ridge diagonally across the parietals to the median crest of the supraoccipital. The combined width of the parietals is 1.40; two large foramina passing into the squamosals at the point of greatest width just behind and medianly from the zygomatic process of the squamosals. The squamosals are long and narrow, measuring 1.40; the zygomatic process being nearly horizontal and only slightly curved at the very end. The interparietal is so small as hardly to be noticed. The skull is flat behind, the supraoccipital being 1.50 wide and but 1 high. The par-occipital processes are moderately prominent and nearly vertical. The foramen magnum is nearly 0.60 wide and is lemon-shaped. The premaxillary is very large, 0.80 long, and sends up two very large flat plates which incline backward and outward. The opening of the nares is thus an inverted truncate triangle. The premaxillary extends beyond the nasals considerably. The main portion of the maxillary seen from the side is nearly an isosceles triangle; the palatal portion is small and ridgy; the infra-orbital foramen is immense, leaving two slender columns to support the zygoma. The palatal is greatly reduced, the last molar being entirely back of the palate. The molar series are inclined to each other at an angle of 30°; the outer margins if extended forward meeting at the incisor or a little beyond. The malar is 1.40 long and greatly expanded anteriorly while its posterior end is knobbed and inflexed.

The basisphenoid is 0.55 long, and its pterygoid processes are short but prominent and soldered on to the bullæ which are prominent and large. The basioccipital is nearly 0.60 long along the median line. The lower jaw is massive; the angle of the mandible being inflexed, making a large shelf on either side. The condyle with its ascending ramus is blunt and short, while the coronoid process is but an inconsiderable spur on the front edge of the ascending ramus. Length of mandible 2.80; hight of ascending ramus 1.30; length of molar series 1.11. The pattern of the molar crowns seems, at first, very uniform, but a more careful study shows considerable variation. There is an outer and inner enamel layer forming a double wall about the tooth when worn. The size and general contour of the teeth are alike in all of the sixteen teeth, but various minor differences occur. In general each crown consists of two opposite semilunes united in the middle; each semilune consists of an outer and inner enamel wall, and these may be parallel or the inner one may be folded upon itself. In some cases, between

the semilunes are interpolated folds or figures, and here certain transitional stages seem to show that the outer and inner enamel layers are parts of the same layer. The details may be gathered from the figures.

CONCLUDING REMARKS ON THE DISTRIBUTION OF RODENTIA.

The rodents are perhaps the most widely distributed of the orders of Mammalia, yet but one of its families (*Muridæ*), including the universally distributed rats and mice, is found represented in all the major land areas. In this respect the hares and squirrels (*Leporidæ* and *Sciuridæ*) come next, they being found everywhere except in Australia and Madagascar. In the former the only members of the placental Mammalia are six genera of mice of which four are not found elsewhere, while in Madagascar three genera peculiar to that island alone occur. South America is richest in rodents and, except for a few genera shared with North America, is the exclusive habitat of its species. Thirty-seven genera are credited to it of which thirty-two are endemic.

Africa is next in numerical richness and affords about thirty genera, several of which are found also in India and the Mediterranean province, only twenty-one being endemic. The Northern continents are less rich in species and exhibit the customary uniformity. The palearctic region has some twenty-five genera of which only about fifteen are not found either in India, Africa or North America. Southeastern Asia is remarkably poor in species, and the few genera considered endemic are nearly allied to widely distributed groups. North America, although possessing several peculiar types, is closely similar to the Asiatico-European continent in its rodents.

These facts lead to the assumption that the rodents are derived from several ancestral lines which have continued independent in the principal discrete land-areas. The principal centres of divergence are supposed to be in South America and Africa. Most of the important families are represented by remains as early as Eocene Tertiary. In Europe, during that period, there lived members of the existing genera *Sciurus*, and *Myoxus*. There is some reason to suppose that the squirrels appeared in America rather later than in Europe, although the synchronousness of epochs of like names in the two continents is pure assumption. Remains of *Sciurus* have not been found earlier than the Miocene here, while in the Eocene there were types of such extinct genera as *Paramys* and *Sciuravus*.

The mice appear in both Europe and America in the Eocene, some naturalists identifying the genus *Arvicola* in South American strata of that age. In the Miocene many additional forms appear as, in Europe, the jumping mouse (*Issyodromys*), the beaver, and beaver-like animals (*Chalicomys* and *Steneofiber*). The Miocene was the time when the rodents expanded to their present proportions, since which time few changes of importance have taken place. The progenitor of the Rodentia is as yet undiscovered, and speculation will have little weight until some truly intermediate forms are discovered. The oldest remains thus far discovered are truly rodent-like.

CHAPTER VI.

THE ARTIODACTYLA.

THE HOOFED QUADRUPEDS.

THIS large group of mammals is a part of what was once termed *Pachydermata*, i.e., the thick-skinned mammals. Throwing out the elephants, which are really very different from any other mammals whatever, there certainly is a considerable degree of unity of structure among the members of that group, horses and cattle being structurally as well as casually associated. The artiodactyle or even-toed mammals are of large or medium size and of various form and habits. The herbivorous habit prevails and the feet are usually much modified from the fundamental form. The structure of the feet furnishes the most obvious distinction upon which the group is founded, since all the *Artiodactyla* split the hoof. The two halves of the hoof represent the third and fourth digits, while the first and fifth digits in the living forms are not functional, but hang as useless pendants above the hoof as seen in domestic cattle. The ancestral forms, so far as they have been discovered, had at most four subequal toes, the first digit being always absent. The hippopotamus may be reckoned as among the archaic types of the group and differs from all other recent forms in still retaining the four toes. In this case, as in ancestral forms, the bones of the forearm and lower leg and the metacarpals and metatarsals are distinct and the paired bones are nearly equally developed.

In the swine a remarkable reduction is encountered, for the fifth and second digits are shortened and the bones reduced. The bones are, however, still distinct and the hoofs are still carried as reminders of the earlier conditions.

In the peccaries of South America the reduction is carried still farther. The inner toe of the hind foot disappears and the metatarsals are partially united. In the genus *Hyomoschus* (Chevrotain) a similar reduction is exhibited. Tibia and fibula are present and distinct, the metacarpals are distinct, while the corresponding bones in the posterior extremity are united more or less throughout. All other living ruminants (and the *Hyomoschus* is a very old type, its bones being found in the Eocene period) have the metatarsals and metacarpals fully united, only a groove indicating the line where the two bones have united during the embryonic life of the animal. Giraffes exhibit the last stage in the process. Here the bones are fully united and the accessory hoofs disappear. The history thus preserved in a fragmentary way in the living examples of the *Artiodactyla* is completed and supplemented in the records of paleontology.

We discover a marked similarity with the history of the development of the horse in the above account of the modification of the hoof in the even-toed group.

The primative artiodactyle, it may be presumed, had 44 teeth, three incisors, one canine, and seven teeth in the molar series in each half of the jaws. Even in ruminants which suffer the greatest reduction from the type, the rudiments of these teeth are found in the embryo and simply fail to develop.

In the Eocene period there existed a curious form called *Anoplotherium* which had a full set of teeth in an unbroken series. A reduction in the number of teeth during the ages is not less remarkable than that of the digits as above described, and here too modern representatives of the various stages of the process remain. In the swine there are six incisors above and below, the hippopotamus has but four above, the camel only two, and cattle none. The reduction in the number of the teeth and especially in the canines is indicative of a change from omnivorous to herbivorous habits. It would seem, moreover, that when the incisors cease to be developed into weapons either offensive or defensive, there is a tendency to produce excresences from the skull above—in other words horns, antlers, or their equivalents.

The number and structure of the teeth varies with the complexity of the digestive organs. In the swine and other omnivorous ungulates the stomach is simple while in the ruminants it is divided more or less fully into four sacks or compartments which have various functions. The most important parts are,

first, the *rumen* into which the food is taken as it is eaten. The *net* is a shallow sack so placed that the coarse unmasticated food is directed into the rumen, while after it is regurgitated and finely comminuted it passes through a groove into the *leaf stomach* and finally into the fourth compartment where the gastric juice is freely mingled and the digestion proper begins.

Intelligence is not great, as a rule in the group, the brain being small and the organs of sense only moderately developed. In some species which are little able to protect themselves, the senses of sight and smell are highly developed and caution and powers of flight supply the place of craft and other mental endowments. The habits are comparatively uniform and are chiefly interesting on account of the various ways in which they are made to minister to man's necessities.

It is almost as difficult to understand how civilized nations would do without kine, sheep, goats, swine, etc., as to imagine a Laplander living without the reindeer or a desert Arab without the camel. I need not refer to the sport furnished by the various deer and antelopes the world over.

The placenta is diffuse and the mammæ are ventral or inguinal.

The swine constitute a very old group and, like many another old family, have preserved tolerably connected records from the earliest times. Even in the Eocene period we find swine with two hoofs (*Entelodon*, *Chœrotherium*,etc.,) while in the mid dle Miocene members of the modern genus *Sus* are encountered In the Eocene gypsum beds of Montmartre are four-toed swine of the genera *Chœropotamus* and *Hyopotamus*. In the Miocene an offshoot furnished origin to the comparatively recent family of the *Hippopotamidæ*. The genus *Merycopotamus*, remains of which are found in India, afforded a transition to true river-horses with six incisors. During the quarternary the various forms, some of which were hardly larger than a hog, others larger than the leviathan of the Nile, disported themselves in the shallows of the inland seas of Europe as far as Ireland. A colder period drove them across what is now the Mediterranean and from similar causes they became extinct in India also. At present, the two species are strictly confined to the continent of Africa.

Two distinct geneological trees are required in the study of the swine proper. In America there seems never to have existed any animals of the genera *Sus*, *Porcus*, or *Hippopotamus* or even of related genera.

Nevertheless herds of wild swine have doubtless roamed over parts of Minnesota as in the states farther west. Since the Eocene period America has had a group of swine like animals in general appearance like those of Europe though quite different in details. The peccary of South America is at the hither end of this line of descent, while at the other stands the genus *Eohyus* of the Eocene, followed by *Helohyus* of the middle Eocene, *Perchœrus* of the lower Miocene, *Tinohyus* of the upper Miocene, *Platygonus*, etc., of the Quarternary. It may perhaps be interesting to notice that, as usual, America has "gotten the start of" the old world and our hogs exhibit a greater degree of specialization than those of Europe and Africa, and the four-toed form has quite gone out of style.

We have already noticed that the family *Tragulidæ* as represented by the *Hyomoschus* seems to have persisted with little change from the upper Eocene to the present time. Deer and antelope were differentiated in the Miocene. During the Pliocene and Quarternary gigantic deer ranged over Europe and America, whose direct descendants are seen in the elk or more properly Canadian stag and the stag of Europe. The gigantic Irish elk lived until comparatively recent times. In America the *Casoryx*, characterized by a non-fusion of the metatarsals, existed in the Pliocene. Antelopes ranged over Europe in immense herds in late geologic periods. During the Ice period both America and Europe were over-run by reindeer, moose deer (properly elk) and musk oxen.

The ancestors of the domestic cattle are found in Pliocene rocks of Asia and Europe, the type being entirely absent from America.

The European buffalo is apparently earlier than the ox, as indicated by fossil remains. Asia has remained the home of the kine group whence indirectly our domestic ox must, in all probability, be derived from three species living at no very distant date in Europe. The *Bos primogenius* is said to have been partially domesticated in Europe during the middle ages and is described as black with a white stripe above. Lineal descendants of this form are said to still exist in a half wild condition in Scotland. *Bos frontosus*, an extinct species with a broad concave forehead is said to be the progenitor of the short-horn breeds and *Bos brachyceros* of the spotless and large-horned breeds. Africa has no endemic species of ox, the probability being that the zebu has been imported thither.

In Egypt in ancient times three varieties were domesticated which must certainly have been imported. Sheep and goats seem to have sprung from some forms of antelope—indeed the musk ox may be said to be a transition between goats, antelopes and the oxen. None of these are endemic in America but we now have one representative of each in the Rocky mountain goat, big-horn sheep, prong-horn antelope, and musk ox. The bison seems to have been individualized in America in the Pliocene and in Europe a form appeared in the Quarternary which forms the direct transition to the present European bison.

The camels are of American origin. The genus *Parameryx* appeared in Eocene and the peculiarities became more marked in later forms. The llama once ranged over most of North America. The camel appeared in Asia in the Miocene and seems to have been introduced into Africa at a very early day.

The primary sub-divisions of Artiodactyla are two:—*Polydactyla*, including the hippopotami and the swine and, the *Bidactyla* or *Ruminantia* (cud-chewers.)

The first of these groups has, as we have seen, no representatives within our limits and the number of ruminants is very small. At present four species of the family *Cervidæ* are the only members of the vast group of ungulates found in Minnesota.

Family BOVIDÆ.

Genus BISON. Smith.

The two living species of this genus are, strangely enough, found one in America the other in Europe and Western Asia. The European species seems at present to exist only in the great forests of Lithuania and in the inaccessible regions of the Caucasus. Our own species is now limited to an almost equally limited area and without the official protection afforded the European species will soon become extinct.

Externally the bisons are distinquished by the great development of the anterior extremities, especially the "hump" over the shoulders, the relatively light posterior part of the body, broad, convex forehead, short conical horns with a decided upward curvature, and the shaggy coat and heavy mane. The nearest relative is found in the yak—*Bos (Poephagus) grunniens.* The gaur and gayal—*B. gaurus* and *B. frontalis* are also nearer than members of the restricted genus *Bos.*

The forehead in the bison is actually and relatively wider than in the ox, the horns also are set farther forward while the plane of the occiput is semicircular forming an obtuse instead of acute angle with the forehead. The intermaxillaries are triangular and shorter than the nasals. The spines of the dorsal vertebræ are elongated, the limb bones are less massive than in *Bos* and the cannon bone of the hind limb is relatively longer.

Fig. 19. Bison europeus.

While a great deal has been written upon the genealogy of the bison the diversity of opinion is very striking. Ruetimeyer, Brandt, Lilljeborg, Vogt, Allen, Leidy and Schmidt have all given attention to the subject without placing it beyond dispute. It would seem most probable that the earliest bison properly so-called was the gigantic *B. latifrons* which may have had a circumpolar distribution. Since this species is found in America only thus far it may be that America is the true place

of origin of the genus. Two species of smaller but still considerable size then appeared, one in Europe the other in America. *B. priscus* of Europe and *B. antiquus* of America may reasonably be assumed as the forerunners of the existing aurochs and the American bison. These differ from each other apparently more than the two earlier species from which they sprang.

The *B. latifrons* must have been of enormous size, the horns being in the male not less than six feet long. The horn cores at the base measure 20 inches, the forehead being over fifteen inches wide. The existing remains were derived from Kentucky, Texas and Mississippi, associated in some instances with the mastodon and horse, as well as other extinct species.

Bison antiquus is known from quite a variety of remains, but so imperfect are they all that it remains a question whether they are not specifically identical with *B. latifrons* or perhaps with the extinct European *B. priscus*. The evidence seems to favor the existence of a species smaller than *B. latifrons*, but still of greater size than our living species characterized by larger proportional horn cores and other differences. The remains referred to have been found in California, Alaska and Kentucky, and in connection with extinct elephants, tapirs and horses. For a discussion of the evidence bearing on these matters, refer to Allen's monograph, forming Part II, of Vol. I, of the Kentucky Geological Survey Memoirs. It would be of interest if it were possible to determine from what time our modern species dates, yet, although the species is found fossil in the bone caves of Pennsylvania and the deposits of Big-bone Lick, Kentucky, we only can conclude that its remains are always later than those of the mammoth and mastodon, and do not reach a great antiquity. Prof. Shaler thinks it probable that the bison did not co-exist with the mound-builders.

Bison americanus GMELIN.

Plate IV.

We rely in many details of the description upon that given by J. A. Allen and refer the reader to his monograph for bibliography.

An adult male measures about nine feet from the muzzle to the root of the tail—thirteen and one-half feet to the end of the tail. The female measures six and one-half feet to the inser-

BISON AMERICANUS. AMERICAN BISON.

tion of the tail, and has a shorter terminal pencil upon the tail.* The male stands nearly six feet high at the shoulder, including the protuberance, or "hump," which is so characteristic a factor in the ensemble of the animal. The female is twelve inches shorter and is but four and a half feet high at the hip, while the male is four and two-thirds. A large male may reach a weight of nearly a ton, while the females range from one thousand to fifteen hundred pounds. The horns are short and in the males are very thick at the base, curving rapidly upward, outward and recurving to the end, becoming rapidly contracted to the sharp apex. In the female the base is smaller and the horn is more slender and curved. The muzzle is broad and naked as in other *Bovidæ*. The hoofs are short, broad and rounded, those of the hind feet being most pointed. The pelage is woolly and dense, furnishing a valuable and much prized article of commerce. The prevailing color is a dark brown, darkest on the head, legs and tail, the long hairs of the latter being restricted to the terminal pencil. In summer the color is lighter, and in old individuals it becomes permanently bleached out to a yellowish grizzle. Young animals are dark brown, though the calf is lighter. The "hump" and head are covered by a mane of considerable length. The chin and throat are also bearded. The mane extends down the median line above nearly to the tail, and there are tufts of shaggy hair about the legs. The female, though smaller is not noticeably different from the male in color. Although albinism is rare, specimens are sometimes found partly or nearly entirely white. Such a specimen is now (1886) on exhibition in the museum of the State University of Minnesota. Black or melanic forms also occur.

The American bison is smaller than the European but has larger shoulders. It seems to be more highly specialized. The pelvis is much smaller and the tail shorter in *B. americanus*. Allen finds the ratio of humerus and radius to femur and tibia as 75–83 to 100 in *B. americanus*, and as 78–84 to 100 in *B. europeus*. The only constant differences in the skull seem to consist in a greater massiveness of the bones of the skull of the aurochs. The individual variation is as great as in most of the larger mammals. This is supplemented by a tendency to form local varieties, two of which are sometimes recognized, the *wood buffalo* and *mountain buffalo*. The former is said to be

* A curious error occurs in the explicit measurements given by Allen, making the total length of the tail four inches less than that of its pencil of hairs.

rather larger and darker colored than the bison of the plain. The mountain variety is not probably essentially different.

The bison is a perpetual nomad; indeed, the gregariousness of the animal makes this a necessary corollary. The migrations of the herd are caused by seasonal changes which drive them northward, or toward the mountains at one time and in the opposite direction at another, but the details of their wanderings are controlled by chance variations in food and water. The vast herd, often thousands strong, consumes and destroys large areas of herbage in an incredibly short time and the mammoth pastures of our continent were none too large for the buffalo in their best estate. The prairie fires and inroads of locusts were frequent causes of change of base, while the position of streams and springs acted as determinants upon the course of the moving column. Before the encroachment of settlements and other interference the major migrations were so constant and uniform that the approximate date of the arrival and departure of the herd could be predicted quite closely. Like most animals accustomed to travel in large companies the buffalo loses to a large degree its sense of individual responsibility, and acts but as a member of the community, rushing blindly on in case of danger, impelled by a common instinct, and frequently plunging headlong into dangers which an individual alone would avoid. They are said to evince great dexterity in climbing and descending steep banks and make good headway over steep ground, although generally choosing the most direct and level routes. When upon their migrations herds frequently cross large rivers, buffeting a rapid, ice-filled current with undaunted courage. At times great losses are suffered in the crossing of such streams, especially when great herds crowd upon the ice. Stupidity and "bull-headedness," which are marked characteristics of all bovines, seem to be unusually developed in the bison, and in the exhibition of these traits it gives evidence of what in another animal might be regarded as courage. In reality, however, the buffalo is timid and distrustful. A very remarkable trait is repeatedly referred to by those familiar with its habits. The animal is not stopped by any danger in front but is frequently thrown into great confusion by unwonted objects in the rear, as the incident given by Colonel Dodge, in the Chicago Inter-Ocean, 1875, will illustrate.

"The winter of 1871–72 was unusually severe in Kansas. The ponds and smaller streams to the north were all frozen

solid, and the buffalo were forced to the rivers for water. The Atchison, Topeka and Santa Fe railroad was then in process of construction. If a herd was on the north side of the track it would stand stupidly grazing and without symptom of alarm, though the locomotive passed within a hundred yards. If on the south side of the track, even though at a distance of one or two miles, the passage of a train set the whole herd in the wildest commotion. At its full speed and utterly regardless of consequences, it would make for the track, on its line of retreat. If the train happened not to be in its path it crossed the track and stopped, satisfied. If the train was in the way, each individual buffalo went at it with the desperation of despair, plunging against or between locomotive and cars, just as the blind madness chanced to take them. Numbers were killed, but numbers still pressed on only to stop and stare as soon as the obstacle was passed." But notwithstanding the traits largely resulting from the communism in which the animal lives they are balanced by others representing the virtues belonging to social existence. The buffalo is no wise lacking in evidences of affection and parental solicitude.

The bulls invariably range themselves about the circumference of the herd while the cows and calves remain in the center. The larger herds when feeding break up into smaller groups, which preserve the same arrangement in obedience to instinct. It appears that the notion long prevalent that certain old bulls stand as sentries upon the outskirts of the herd is fallaceous, most observers claiming that it is the females with anxiety quickened by the maternal instinct, which are usually first to perceive danger. The picture presented by a huge composite herd when alarmed, uniting, forming into a solid column and plunging across the plain, is grand indeed, while hardly less interesting is the sight, alas, to be seen no more, of thousands of God's cattle grazing in undisturbed quiet on their appointed hills. Many incidents have been related of the devotion of the buffalo cow to her offspring in danger, while the contrary reports seem to be due to circumstances occasioned by the dominant social instinct where the individual was lost in the social instinct.

In some cases it is the males upon whom the office of protection devolves, especially in case of attack by wolves. Wolves were the only animals molesting the bison until the advent of man, and before their numbers were so reduced by hunters these marauders constantly harrassed the herds. Indeed, it

seems not improbable that the habit of going in herds may have had its origin in the necessity of protection against these enemies. When separated from the herd the mother was often obliged to pass the night in sleepless vigil, pacing about her sleeping calf. The following extract from a letter from Mr. Upham is suggestive in this connection:

"When this part of the state was examined in 1881, the disappearance of these animals was so recent that their bones, especially their skulls, were frequently seen on the prairie. In many places, also, rings of taller and greener grass than the ordinary prairie sward, were observed, having a width of five or six feet, and forming a circle from two to six rods in diameter. According to Mr. James Nolan, of McCauleyville, these mark a circuit tramped by buffalo cows while walking around their calves at night to guard them from besieging wolves. Occasionally a half circle of such grass was seen, and this was said by Mr. Nolan to be be where a lone buffalo guarded her calf from a single wolf, which staid on one side through the night, while the buffalo walked back and forth in a half-circle." Colonel Dodge gives an interesting account of the way in which a party of bulls rescued and brought safely out of the jaws of the wolves a newly born calf. Wolves do not confine their attacks to the young, but harrass and destroy the old and wounded. Catlin draws a pathetic picture of the old and decrepit bull standing on the defensive against an overpowering number of wolves, even after eyes and much of the flesh of the head had been torn away. Evidently the sluggish and stupid buffalo could not long expect to escape the ruthless mounted hunter. The white man with his firearms has rapidly brought the whole race to the verge of extinction.

In most respects the habits of the bison are like those of domestic cattle. The propensity to rub upon any suitable object has resulted in the polishing of the few projecting rocks and trees found upon the prairies. This effect has sometimes been referred to the action of blown sand. Mr. Upham kindly furnishes notes from the Red river valley, which I transcribe: "The few large boulders, three to five feet or sometimes more in diameter, which are found jutting above the surface of the prairie plain of the Red river valley (excepting within a few miles next to the river, where the surface is alluvial clay) and through the west part of Minnesota further south, are usually surrounded to a distance of five to ten feet from them by a slight hollow, about a foot below the general surface, but there

is no perceptible ridge outside the hollow. This feature is doubtless due to the pawing of buffaloes in former years while rubbing upon the boulders, the dust loosened in this manner being blown away by the winds. Mr. Pierre Bottineau, a very experienced and observing voyageur and guide, still living at Red Lake Falls, attributes the polished surface of such projecting boulders, and of the ledges of rock in Pipestone and Rock counties to rasping by the hair and horns of buffaloes in this way; which seems more probable, than that this polishing was done by wind-blown particles of sand and dust. (See Geol. Nat. Hist. Surv. Minn., vol. i, pp. 63, 66 and 541; 1884). Catlin's descriptions make it certain that the polished rock-surfaces in the vicinity of the Pipestone quarry were much more noticeable in his time than now." Similar observations and explanations are recorded by Dr. George M. Dawson in the region of the Bow and Belly rivers east of the Rocky mountains in British America, where he states that "all the larger boulders of the district are surrounded by a shallow saucerlike depression, caused by the pawing of the buffalo, and their angles are worn quite smooth and glossy by the rubbing of these animals upon them." (Rep. Prog. Geol. Surv. Canada, 1882–'84, p. 149c.)

Mr. Upham also writes, "another notable feature ascribed to buffaloes is the very rough surface often found on areas of slightly moist land in the Red river valley, the ground being indented by many hollows and holes five to twenty feet across, and one to five feet deep, with steep sides. These are commonly called 'buffalo-wallows'." This propensity to wallow and roll in the mire reminds one of the buffalo proper of warm regions, and is not found in the animals of the genus *Bos*. Allen says, "their especial delight is to roll in the mud, or in 'wallowing' as it is called, from which exercise they arise looking more like an animated mass of mud than their former selves. The object of these peculiar ablutions is doubtless to cool their heated bodies and to free themselves from troublesome insects. When not finding a muddy pool ready at hand, an old bull proceeds to prepare one. Finding in the low parts of the prairies, says Catlin, a little stagnant water amongst the grass, and the ground underneath soft and saturated with moisture, an old bull lowers himself upon one knee, plunges his horns into the ground, throwing up the earth and soon making an excavation into which the water trickles, forming for him in a short time a cool and comfortable bath, in which he wallows 'like a hog in the mire.' In this 'delectable lava'

he throws himself flat on his side, and then forcing himself violently around with his horns, his feet, and huge hump, plows up the ground still more, thus enlarging the pool till he at length becomes nearly immersed. Besmeared with a coating of the pasty mixture, he at length rises, changed into a 'monster of mud and ugliness.' with the black mud dripping from his shaggy mane and thick woolly coat. The mud soon drying upon his body insures him hours of immunity from the attack of insects. Others follow in succession, having waited their turns to enjoy the luxury; each rolls and wallows in a similar way, adding a little to the dimensions of the hole, and carrying away a share of the adhesive mud. By this means an excavation is eventually made having a diameter of fifteen or twenty feet, and two feet in depth." Similar excavations are made upon the dry prairie and receive the same name. However formed, these cavities serve a useful purpose as reservoirs of rain water for man and beast, and in not a few cases during the exciting Indian wars such wallows have formed natural rifle pits in which a small band has been able to resist the onslaught of a much superior force of savages. The wallows may be detected from a distance by the greener and ranker grass of the margin.

Rutting takes place in July and August and one, or at most two calves are dropped in March to June. The young consort with the cows and younger bulls, but do not form separate herds. Conflicts plentifully intermixed with sonorous bellowing are frequent but so short are the horns and so tough and shaggy the head that serious results are rare. Even when enraged the buffalo is rarely the formidable and pertinacious foe represented in penny books of adventure.

The buffalo is easily tamed and the cross with the domestic cattle is fertile. Great diversity of opinion prevails as to their availability for domestic purposes. Some suppose that great improvement in domestic breeds of cattle could be secured by crossing with the wild relatives but the preponderance of evidence seems rather to negative the assertion.

The attempt was made at one time in Virginia but the results were unfavorable. It would seem that a race of draught oxen might be reared from this stock but no persistent experiments have been made. Sibley speaks of a man who in the Red river valley had broken a bull to the plow and performed the whole labor of the field with him alone.

There is no doubt as to the fertility of the cross and the size is increased, but the beef is rather inferior and milking qualities have not been tested, while the traits of the wild animal to some extent persist. It is very desirable, however, that the experiment should be more carefully made. Since it is doubtful if the project is sufficiently alluring to attract private enterprise it would seem legitimate for the government to establish preserves where such experiments should be systematically undertaken.

In this connection the following clipped from the *Week's Current* of January, 1887, may be of interest:

"A gentleman is now successfully domesticating the American buffalo at Stony Mountain, Manitoba. Starting his herd is 1878 with five calves, it now numbers sixty-one head; the greater number pure buffaloes, the rest half-breeds. In January they were all sleek and fat, and yet, they were then living on the open prairie and feeding on the prairie grasses covered by snow. At this time the snow was deep and the thermometer had for a long time registered 29° or more below zero. When a blizzard comes on, the animals lie down together, with their backs to the wind, and allow the snow to drift over them, so that under the combined protection of their own wool and the snow they are quite warm. Not one of the herd has ever exhibited the slightest symptom of disease, although the only care they receive is occasional watching to prevent them from straying away. Thus winter and summer, they live and thrive on the bare prairie with numbers undiminished by any of the ordinary cattle scourges and with expenses reduced to a minimum. When the present herd is sufficiently increased, it is intended to divide it among several prairie ranges where once the buffalo roamed at will."

Before the introduction of horses and fire-arms from Europe the pursuit of the buffalo was attended with exhibitions of skill and prowess no longer requisite. But even then numbers of the attacking party and the unsuspicious nature of the game robbed the chase of much of its interest and made it too much like wholesale butchery.

On the prairies of the west the season of the buffalo hunt held a marked place in the Indian calendar. Prolonged preparations were made and it issued in festivity and unusual activity. In many places the herd was "corralled" by fire and the animals, blinded and alarmed by the flames, rushed unsuspectingly upon the hunters who had their own way with them. In other

places the animals were impounded and destroyed at leisure. The pound was an enclosed area about 125 feet in diameter, formed by posts planted at regular intervals, guarded by the women and children of the tribe. Series of posts diverged from the opening and served to direct the herd toward the latter. Several hundred buffaloes were frequently enclosed when the slaughter began. Deprived of even the usual degree of intelligence by fear, the enraged animals assisted in their own destruction, though in some cases an unusually adventurous bull forced an opening and led the whole herd safely through the cordon of yelling savages.

Another method, rather rarely resorted to, was to take advantage of their stupid tendency to follow the leader and lure the whole herd to destruction. An Indian disguised himself with a partially stuffed skin and, attaching himself to the herd just as the alarm was given on the other side, led the way to a precipice. There he secreted himself in a crevice, while the buffalo following were precipitated to the bottom. This method naturally was attended with no little danger to the one leading in it. Since the introduction of horses sometimes a cordon of horsemen was substituted for the pen with nearly equally fatal results. The more modern method is for a number of well mounted horsemen to strike well into the centre of the compact herd and thus stampede them, after which an indiscriminate slaughter is carried on as long as the scattering animals can be pursued. The modern hunter follows the same plan essentially but improved firearms and better horses make it a much more destructive matter. As long as the buffalo still roamed over the plains of Kansas and the Red river, buffalo-hunting was a business as well as a pastime for many. The pot-hunter however preferred the still hunt as more safe and productive. Buffalo-hunting has always been most wasteful. The excitement is so great that neither reason nor fatigue reminds even the thoughtful that his sport is sheer improvidence until the last individual is out of reach. The Indian rarely used a tithe of the slain animals and modern hunters have not been less extravagant. One man often destroyed thousands during a single season. Mr. Allen in his monograph gives very full statistics of the rate of destruction of the buffalo. He says "at the time of the completion of the Atchison, Topeka and Santa Fé railroad to Dodge City, which occurred Sept. 23, 1872, the principal trade of the town consisted in the outfitting of hunters and exchange for

their game. The number of hides shipped during a period of three months, beginning with this date, is reported to have been 43,029, and the shipment of meat 1,436,290 lbs.," the number killed around Fort Dodge during four months being estimated at over 100,000. During 1871 hides and meat representing over 20,000 individuals were shipped over the Kansas Pacific railway. In 1876 but few remained scattered about their former range in that region but since then these too have, it would seem, been entirely exterminated. Thousands were killed for sport and many more for no adequate return—perhaps the tongue or a dainty morsel.

Allen estimates the total destruction between 1870 and 1875 as not less than two and one half millions annually. This explains the nearly complete extermination except in the almost inaccessible regions to the far north. The flesh of the buffalo when young is tender and juicy but only the tongue and flesh of the hump are regarded as delicacies. Buffalo beef furnished the material for the manufacture of pemmican for the fur countries. It was thought by the early explorers that the woolly hair of the buffalo would become an article of commerce. The Indians spun and wove it into a variety of articles and ornaments but it has never been utilized by the whites. The bones and even the excrement are of value, the latter especially, the so-called "buffalo-chips" have aided materially in settling the treeless regions. Without this substitute for wood it would have been impossible to secure fuel for many a weary mile.

An exhaustive study of the former range of the buffalo has been made by Allen. They were common in Minnesota up to a comparatively recent time. In 1823 Major Long encountered thousands about Big Stone and Traverse. In 1844 Captain Allen encountered herds in southwestern Minnesota. "Seventy-five miles west of the source of the Des Moines we struck the range of buffalo, and continued in it to the Big Sioux river and down the river about eighty-six miles." In 1850, according to Pope, buffaloes were abundant between the Pembina and the Cheyenne rivers. Stragglers seem to have visited the southwestern part of the state as late as 1869. They were driven out of the region east of the Mississippi before 1835 though found within fifty miles of St. Paul somewhat later.

The location of a midland route to the Pacific coast cut the range of the buffalo in two and the completion of the Union Pacific railroad made the separation permanent. The rapid extermination of the buffalo to the south of this line followed.

The original habitat as laid down by Allen is as follows:

Beginning with the region east of the Mississippi river, its extension northward was limited by the great lakes, while the Alleghanies may be taken as its general eastern limit. To the southward it seems never to have been met with much south of the Tennessee river. It is well known to have ranged over northern and western Arkansas, and thence southward over the greater part of Texas, and across the Rio Grande into Mexico. Westward it extended over northern New Mexico and thence westward and northward throughout the Great Salt Lake basin, and probably to the Sierra Nevada mountains in California and the Blue mountains in Oregon.

North of the Uuited States its western boundary seems to have been formed by the main chain of the Rocky mountains, along the foot-hills of which it has been found as far north as the Mackenzie river. Its most northern limit seems to have been the northern shore of Great Slave lake. In the British possessions its range to the eastward did not extend beyond the plains west of the Hudson's bay highlands. It was hence wholly absent from the region north of the Great Lakes.

Family CERVIDÆ.

Alces americanus Jardine.

MOOSE DEER.

PLATE V.

This, the largest existing ruminant in North America is exceedingly uncouth and ungainly, and more ox-like in many respects than any other member of the *Cervidæ*. The body is massive and compact and relatively short, being concentrated anteriorly. The legs are very long and stout, especially the forelegs. The hoofs are large and ox-like, and the "dew-claws" large and pendulous. The metatarsal gland is absent. Tarsal gland small and covered with retrorse hairs. The head is massive but narrow, and reminding somewhat of that of a horse, the nose, however, is enormous and hairy, except a space between the nostrils. The ears are very large. The antlers, which complete the bizarre physiognomy of the male, are relatively but moderately large and spreading, forming, by the expansion of the beam and coalescence of the lines, a broadly-palmate shovel-

ALCES AMERICANUS, MOOSE DEER.

like organ, adapted to be used in the excavation of food buried beneath the snows of the frozen regions chiefly inhabited by the animal. Though, as before said, relatively short, being rarely over twenty-five to thirty inches long, the antlers of the moose are remarkably massive and strong, and may weigh from fifty to sixty pounds. That such appendages form very effective weapons is obvious at a glance. Three months is required to complete the growth of the antlers in the adult male, which removes the velvet in September. For nearly two months during the rutting season, the antlers continue to receive nourishment, and the antlers may be worn to January, February, or even March following. The young carry the antlers longer; for instance, the young bull moose gains its first antler, consisting of a small cylindrical dag, in its second summer, and carries it until April or May following. The antlers of the next year are bifurcate. These appendages continue to increase in size at least to the age of seven years. One to three short tines are added, but not with sufficient regularity to serve as a trustworthy criterion for estimating the age. It is said that although the antlers are used as well as the feet in the cyclopean conflicts of the males, only the latter are employed against dogs, wolves, etc., as though, possibly, the noble weapons nature furnishes were designed only for use in strife with their peers.

The hair which is coarse, stiff and brittle, is very abundant upon the neck and shoulders, often forming a shaggy mane. In summer the coat is more glossy and resembles that of the horse. The color is brown or blackish-brown and admits of a rather wide range of variation. Below, the color is lighter, as also the middle of the nose and insides of the ears.

The females lack the horns and are considerably smaller and lighter colored, at least in the winter pelage. A full-grown male may weigh 1,500 pounds. One or two young (very rarely three) are produced and are very carefully secreted and vigilantly guarded. Upon occasion the mother, in protecting her offspring, may display great ferocity, which is rendered the more formidable because of the gigantic size and threatening aspect of the beast. The family relations of the moose indicate greater fidelity than in any other American deer. Although this constancy is limited to a single season, they are more nearly monogamic than most of our large quadrupeds.

Of external sexual distinctions it remains to mention the "bell" or dew-lap of the moose, which is so nearly confined to

the male as to make it safe, perhaps, to refer those instances of its presence in the female to similar causes, as the inheritance of other sexual characters by members of the opposite sex. This pendulous flap of the skin of the throat seems to serve simply a purpose, which, from the paucity of our vocabulary, we must term ornament, though by no means implying by this that it is designed merely to gratify the taste of wearer or viewer.

The nearest existing relative of the moose is the elk of Northern Europe. Unfortunately, by one of those frequent transpositions in popular nomenclature, the name elk has in this country been applied to the only other large deer-like animal, though the latter is hardly specifically distinct from the European stag. Although subject to a wide range of variation the species under consideration present in a comprehensive view appreciable distinctions. While, therefore, there can be no doubt of their common origin and close relationship, the decision of the question of specific identity must depend very largely upon theoretical considerations or individual judgment. The American moose is larger and of a darker color than the European species, and certain differences in the form and expansion of the antlers are obvious, while the more recondite (and theoretically more valuable) distinctions seem never to have been carefully studied. The configuration of the cranium varies too much in all large mammals and especially in those in which one sex bears horns, and hence more or less of cross inheritance of sexual characters is to be expected, to afford instructive distinctions unless very careful elimination of all variants is made upon the basis of very large and representative collections.

The original habitat of the moose extended entirely across the continent between the fortieth and seventieth parallels, approximately in appropriate localities. The treeless regions were, of course, always avoided by an animal whose chief sustenance is afforded by leaves and bark. A few specimens of this noble animal still may remain in the inaccessible regions of Northern Minnesota, but the time is not far distant when it will have deserted the territory of the United States forever. The moose is at home in dense thickets, such as are usually found about the swamps and shallow lakes at the head waters of northern streams. The long legs and deeply cleft hoofs adapt the animal to such a habitat, while the short neck and prehensile snout sufficiently indicate the impossibility of its

grazing like other deer. The moose is said to feed upon coniferous as well as deciduous trees, which is rather exceptional. In winter higher ground is sought, but still in localities affording abundant "browse." When the snow becomes deep they are said to congregate in close herds and select a limited range which becomes more circumscribed as the snow deepens and becomes encrusted. This is called a "yarding" and a moose yard may occupy nearly one hundred acres. Such yards, when discovered by the hunter, of course, are a capital prize. The females do not yard with the old males, the former often occupying separate yards with their calves. The younger males are quite gregarious, but as age increases a desire for solitude seems to augment till ultimately the patriarch becomes a hermit, nursing his morose reflections in some isolated spot far from the haunts of his kind.

The pursuit of the moose is rendered difficult by the keenness of his senses and extreme wariness. To stalk the animal even with firearms taxes the patience and skill of the Indian. When, however, the snow becomes covered with so firm a crust as to support the hunter and impede effectually the progress of the heavy animal, the chase of the moose becomes comparatively easy to one familiar with its habits and haunts. When hunted at such times the herds pass in single file, each stepping so accurately in the foot-prints of its predecessor as to lead any but an experienced person to suppose that but a single animal formed the trail. When moving rapidly, the leader becomes weary of breaking the way and steps to one side falling in behind the others, and in this way they change in rotation, although a very chivalrous care is exercised in aiding the weaker members of the herd.

During their confinement in yards at the hight of winter the accessible shrubs are very closely cropped, but ordinarily the tree is not killed since only one side is stripped. The bark is removed to a hight of ten feet as the animal rears upon its hind feet and peels the bark. The direction a herd is moving may be ascertained by one familiar with their habits since the bushes browsed are pulled toward the animal. The fir trees are browsed but the bark is not eaten, yet hunters state that young firs suffer more than other species from the habit of the males of rubbing their heads upon them in such a way as to apply the balsam to the abraded skin about the horns. It would be a curious and instructive fact, if substantiated, if instinct teaches the animal the curative properties of the balsam of fir

and the proper method of applying the salve to the tender skin of the scalp. The same instinct is shown in the habit of diving in fly-time to escape the assaults of these pests—if this habit is not the result of the fondness of the moose for the roots of the yellow water lily—*Nuphar*.

The bark of the flowering maple and mountain ash and the twigs of the fir and "moosewood" are said to form the staple winter diet of the moose in some places at least. In summer the white hunter is most successful in hunting the moose by availing himself of the curiosity and antipatly to fire which are prominent traits of the animal. Torch hunting has been already frequently referred to and the process is essentially similar in all cases. A canoe manned by two persons is quietly paddled along the stream or among the water plants of the lake frequented by moose, and the glare of the torch is said to excite the male to a blind rage, making it an easy victim. At the proper season the accurate imitation of the bellow of the male is said to be an effectual means of getting within range. Aside from the loud bellow referred to the sound known by the hunters as "chopping" *i. e.*, the gnashing of the teeth is perhaps the only sound intentionally produced. The only specimen of this animal encountered from Minnesota is that now on exhibition in the museum of the University, but as it was not seen in the flesh no anatomical or other details could be secured.

Rangifer tarandus.

WOODLAND CARIBOU, OR AMERICAN REINDEER.

Fig. 20.

The reindeer are represented in America by two species, and only one of these merely enters the northern outskirts of the United States. The relationship between our species and the European is so close that many writers have hesitated to consider them as distinct. The caribou is much smaller than its relative, the moose, and is even more ungainly and kine-like. The full-grown animal is as large as a well-grown yearling beef, and has much the same stocky form. The legs are shorter and the neck rather longer than in the moose, while the hoofs are broader than in any American ruminant. Like the moose the neck of the male is clothed with a shaggy mane. The muzzle is like that of the ox rather than of the moose.

The color is variable and fluctuates with the seasons; in general, however, it is lighter than that of other deer. In summer it is darkest, the prevailing color being dark brown varying

Fig. 20. Head of an unusually large Caribou.

toward yellowish or reddish. The neck and under parts, including also rump and tail and inside of legs, are white. The brown is deepest and most constant on the head and legs, though the feet are fringed with white. The neck is always light-colored,

and in the male is furnished with a heavy mane. The fur is of two sorts, the inner being dense and soft while the longer hairs are crinkled and pliant. The hide makes a useful leather. The color is lighter on the back than on the sides. The antlers are worn by both males and females, though those of the female are smaller and less palmated. The antlers are more spreading than those of the moose, which they most resemble. Their form is very irregular, but the slender branches are more or less palmated at the end. The feet are very large and the hoofs are flattened, and in form similar to those of the ox ; the dew claws or accessory hoofs are unusually large and are not entirely unfunctional. There is said to be some muscular control of these remnants of the second and fifth digits, which, with their flattened hoofs spread laterally, add considerably to the support of the animal as its makes its way across the bogs, which are its special habitat. The entire lower leg is applied to the ground in such cases, so that the caribou's foot forms a sort of snow shoe. The hoofs are black. Tarsal gland large, metatarsal gland wanting, interdigital gland found only in hind feet.

The antlers of the male are from two to three feet long, the shaft being subcylindrical, with comparatively restricted palms. The brow tines are asymmetrical, one or both descending to about the level of the eyes and one usually expanded in a vertical plane and digitate. The bez-tine may also descend. At the end of the main shaft the palmate part bears a number of posterior tines. There is considerable variation, which would be useless to describe. The antlers of the female are small and little palmate, but bear simply flattened snags. The Barren-ground caribou which inhabits the rocky morasses of arctic America and is most nearly akin to this species has similar antlers, though rather more palmate and proportionally much larger. Indeed, the antlers of the woodland caribou are not half the size of its cousin's, though the latter is about half its size.

The antlers of the European reindeer with which our species is sometimes identified, differ chiefly in that those of the European form are less palmated. To these differences in the antlers we must add the greater size of the American species, as well as its lighter color. The caribou lives chiefly upon lichens and mosses and the browse of small trees and shrubs. The reindeer moss, *Cladonia rangiferina,* species of *Usnea, Sticta* and *Cornicularia* are said to constitute the principal sup-

Fig. 21. European Reindeer.

ply, especially in the far north. In summer they delight to feed upon the rich grass of river bottoms, taking good care, however, to keep clear of the thickets which might shelter their enemies. The writer has encountered the caribou in Minnesota only about the head waters of the White-face river and along the St. Louis river near Knife Falls. There it was in 1884 not rare, though so shy as to be secured with difficulty. Along the north shore of Lake Superior it is less shy and the animals may be seen feeding quietly in groups along the upland meadows. It also occurs in Nova Scotia, New Brunswick and Maine. Thence it ranges west to the Pacific, but does not extend south of Lake Superior. Along the Pacific the range extends nearly to the Arctic, but the Barren-ground species takes the place in central British America as far south as 60° or farther. The range is more restricted eastward perhaps because of the greater rigor of the climate.

Although eaten by the Indians, the flesh is inferior and no attempt seems to have been made to domesticate our species. The hide, therefore, is the most valued article furnished by the caribou, and in a short time, like so many other large animals, the caribou will cease to be a member of our fauna.

Cervus canadensis Erxl.

AMERICAN ELK.

Plate VI.

The only true *Cervus* of Minnesota, and the largest animal in America, except the moose, still exists, though in diminished numbers, in the northern wilderness. The elk may be taken as the type of a true deer, and the poetic associations and fancies which cling to the stag of Europe might better have been engrafted upon this species than the Virginia deer, as has happened. The elk is, however, so much larger than the stag, though by some regarded as not specifically distinct, and so much more rare than the deer that it has come to be regarded as one of the peculiar outgrowths of our own country, while few ever think of the Virginia deer as radically different from the European red deer.

The short body, slender and rather long legs, small feet, slender head and graceful neck, make up the *ensemble* so familiar, at least through illustrations, but no illustration can do justice to the majesty of the stag at bay with flashing eye and threatening antlers. The elk may be regarded as *par excellence* the game mammal of America. The antlers are large and much more uniform in size and form than either of the preceding. The antler consists of the beam or main trunk, in this case cylindrical and polished, chief branches called tines, minor branches called snags, and tubercles. The position and relative size of the tines are of especial importance in distinguishing species. The lowest considerable tine is the brow-tine, extending forward, the next the bez-tine, then the royal, sur-royal tine, etc. In the elk the brow-tine springs from immediately above the burr and forms a gentle downward curve. The bez-tine extends laterally and is nearly of the same size. A considerable interval separates the royal tine, which is smaller than the preceding. The beam now is reduced in size and gives off more or fewer anterior tines which vary with age and otherwise. Occasionally these upper tines spring from the same point forming a depression surrounded by diverging

CERVUS CANADENSIS. AMERICAN ELK.

points. Such cases are called crown-antlers. The first set of antlers are slender spikes called dag-antlers, and it is rare to find any trace of bifurcation. The second set have brow and bez-tines, and possibly other snags. The third year adds the royal tines, and succeeding pairs vary considerable, but continue to enlarge many years. These wonderful organs, produced in so incredibly short a time each summer and dropped in autumn or winter, have always attracted much attention. Though so horn-like these appendages were early seen to differ from ordinary horn which is an epidermal excrescence. They are really peculiar bones left exposed to view by the denudation of their original skin-like covering. So much has been written about the antlers and their development that we need not go into details. A very complete general account may be found in Caton's Deer of America,

The antlers contain more animal matter than ordinary bone, but in most respects the structure is similar. Much obscurity still exists as to the exact physiological explanation of the excitement which causes this growth by concentrating the blood at these points. During the period of growth the sensitive covering or velvet is especially vascular and sensitive, but blood is also supplied by the periosteum below and haversian canals. The velvet dies and is peeled voluntarily, but authors disagree as to whether the cessation of the flow of blood is due to the mechanical closing of the vessels passing to the velvet by the growth of the burr at the base, or by a more subtle process. After the velvet is removed, a process more or less painful and attended with loss of blood, the antlers become hard, and the deer sets about polishing the tips by abrasion against tree trunks and among the boughs. The growth of the antler is dependent on the generative organs, at least largely, and castration causes a curious abortion or malformation, also preventing the shedding at the proper time. It is stated that the elk assist each other in the removal of the antlers, and that heaps of these appendages may be found in places where the males have congregated for this purpose. Of the truth of this we can not vouch. The comparative rarity of such relics is accounted for by some one on the ground that mice at once devour them. The eyes of the elk are prominent and expressive, the ears large and very movable, neck short and flexible, tail very short. The summer pelage dirty yellowish-gray upon the body, with chestnut brown head, legs and under parts. In winter the colors are much darker and sexual differences appear, the

males being darker. The male has the lower parts of the body and neck as well as legs very dark brown, nearly black, while in the female these corresponding parts are chestnut brown. Above, the color is yellowish-brown. The rump is marked by a patch of white, bordered above by black. The young elk is spotted or dappled with dull white, but far less regularly than the fawn of the Virginia deer.

Like the red deer of Europe the elk is gregarious and polygamous, though the number associated is rarely great. The herd consists of several divisions during the breeding season. The oldest or most vigorous buck drives the younger bucks from the herd of does while the young malcontents become companions in discontent. Sometimes some of the females desert the harem and join the buckaneers. No one in America has had so fine opportunities for the study of the elk as Judge Caton, and from his "Antelope and Deer of North America" one may glean ample illustrations of its habits.

In appetite, the elk is not epicurean but eats greedily almost all vegetable food. Grass and succulent herbage as well as the shoots of many trees form the staple diet. In a state of nature the elk breeds at two or three years, producing one, two or three at a birth. The fawns are very active but the mother does not at once join the herd.

The domestication of the elk is so easy that it is a pity it has not been more generally attempted. The writer has seen domesticated specimens at work like oxen and experiment in this line would be at least interesting. The geographical distribution was once enormons—extending far north and south of the limits of the United States. The prairies were rather avoided but all other portions of our national domain were suited to this noble deer. It is now practically extinct in the eastern part of the United States. In the writings of early explorers of Minnesota references to great herds of elk abound. To-day the Indians in the region north of Lake Superior now and then succeed in securing one, but the American hunter is fortunate if he sees a wild elk east of the Yellowstone. Mr. W. W. Cooke of Moorehead informed me that both moose and elk are always found near lakes Itaska and Caribou while in 1885 they were common about Red lake. The cause of the wide range may be found in the fact that the appetite is not delicate and no single plant is the chief reliance of the animal. The chase of the elk can not be regarded as very noble sport aside from the size of the game, as sheer patience and endurance are

the chief factors. Still hunting is the only method available to the white hunter. The Indian formerly succeeded in slaying in a more wholesale manner.

Cervus (Cariacus) virginianus Bodd.

COMMON OR VIRGINIA DEER.

The most graceful and attractive in color of our *Cervidæ* reach only a medium size. The extreme weight may be 250 pounds but the average is much less.

The beautiful reddish-gray which constitutes the prevailing color varies to bright bay or yellowish. The winter coat is lighter and more bluish than that of summer. The lower side of the head to the throat, the belly and inside of thighs, and the inside of the hind legs are white. A dark line marks the median lower line of neck and brisket. The separate hairs are banded with gray, brown, yellowish-gray and black successively, beginning at the base. The head is acute, the nose being naked, eyes very large, ears relatively small. The antlers are spreading and strongly curved from base to tip with backwardly projecting tines, from one to six in number. The number of these tines is only an approximate index of the age, and may vary in the opposite members of the same pair. They reach a considerable size, weighing as much as six pounds. The neck is much more slender in proportion than in the elk, and the body is longer. The tail is longer than any of our deer, and tapers uniformly. It measures from fifteen to sixteen inches and is flattened rather than terete. The body above described is furnished with long and marvelously active legs, tipped with acute polished hoofs, and capable of feats not to be believed till seen.

This deer is more timid and sensitive than the larger species, but when taken young submits to domestication readily. Although moderately gregarious this species is not so polygamous as the elk, and no single buck rules the harem. Fierce fights often occur, however, and continual quarreling occurs during the rut. The fawns are weaned at four or five months but follow the mother, the males for one, the females for two years. The mother tends and guards her young most solicitously. During summer the feeding is done chiefly at night, and grassy,

slow-flowing streams and lily-flecked lakes are favorite resorts. No animal furnishes more real sport than the deer. The weary days spent in tramping through fairly impassable swamps are forgotten in the excitement of the moment when the lordly animal dashes by with gleaming eyes, and gives you a few seconds opportunity for his capture. The prevailing method for stalk ing the deer in the open woodlands of Minnesota is for several to unite, some stationing themselves in the known runways while others beat the denser copses, in hope of starting the animal. The fortunate hunter, into whose beat the deer strikes, has no intimation of its approach except the crash which precedes his appearance. If nerves do not fail, the rifle is prepared, and a ball is sent crashing into the shoulder as the animal springs into the air, to fall in a heap almost at the feet of his slayer. Coursing deer on horseback has never been tried as our state furnishes no opportunity. Jack hunting, if less sportsman-like, is fully as exciting and less fatiguing than any other method. An experience of this sort on the St. Louis river convinced the writer that nerves, usually rather steady, can be stirred by the sudden apparition of luminous orbs, backed by, no one knew what. As much depends on the one who uses the paddle as the actual Nimrod.

A few initiated have succeeded in securing a deer or two near the city of Minneapolis every winter up to very recently, but now this sport must be sought far northward.

Antilocapra americana Ord.

AMERICAN ANTELOPE; PRONG-HORN ANTELOPE.

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ANTILOCAPRA AMERICANA. PRONGHORN ANTELOPE.

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The prong-horn antelope is perhaps the most remarkable ruminant which enters our limits, not only because it is the only antelope of America, but because it possesses several peculiarities which entirely distinguish it from any other ruminant whatever. Although known from accounts of western hunters and pioneers for some time previous, the first scientific knowledge of the animals was derived from the specimen brought back by the Lewis and Clark exploring expedition. As we shall see beyond, this antelope forms the connecting link between the deer and the antelopes, and may be taken as a type long isolated and representing a group of animals of an inclusive type. At present this animal does not set foot within our borders, but at no very distant date, frequently entered the southwestern prairie counties.

In size, the prong-horn is less than the common deer and considerably larger than a sheep. The body is very short and its build may rather be characterized as "stumpy" than elegant. The legs are long but not graceful, while the feet are peculiar in not having either accessory hoofs or hock glands. The neck is not long for a deer, but is carried in an erect, and what seems a rather constrained attitude. The head is large and is redeemed from ugliness by the extraordinarily large eyes. The eyes are said to be larger than those of an ox, and, therefore, relatively larger than those of any ruminant. The color is black, but the expression mild and winning. The eye is protected by ample lashes, especially upon the upper lid. There is no larmier without or internally. The ears are pointed and hairy inside and out, being about five inches long and quite narrow. The muzzle is blunt and hairy with only a narrow naked space in the middle about one-quarter of an inch in width and expanding to include the nostrils. The nostrils are large and less oblique than in the deer. The horns are the

most interesting feature, not of the head only, but of the whole bodily structure. These appendages have not been correctly understood until recently. In two particulars they differ from the antelopes; first, no true antelope has tines upon the horns; but the adult prong-buck has a sharp spur directed forward, and the shaft curves gracefully backward and inward, taking on a distinctly hamular shape; second, no true antelope sheds its horns, while the prong-buck drops its horns annually up to the maturity of the horn. This fact was first discovered by hunters whose practical experience gave their testimony good claim to credence; but even up to Audubon's time this was discredited. Audubon indeed thought he had demonstrated the contrary by showing that the bony core of the horn is completely ossified with the skull. His mistake grew out of the assumption that if the horns are deciduous they must be constituted after the plan of the antlers of the *Cervidæ*. The first statement of the true deciduous character of the horns was published by Bartlett, who, as superintendent of the gardens of the Zoological Society of London, communicated his discovery in the journal of that society. Eight years previous, however, Dr. C. A. Canfield made this discovery and reported the same to Prof. Baird whose caution prevented Dr. Canfield from receiving the credit of priority in this matter.

The horn may be described as partially hollow, deciduous and seated upon a true core of bone about one-half the length of the horn. At the base the horn is corrugated, but there are no annulæ or rings of growth, indeed, the horn is rather longitudinally striate. The length of an adult horn is about ten inches. The general form of the horn is most like that of the European chamois. In the female the horn is shorter, appears later, is always simple and never exceeds three inches in length. This is an instructive fact, inasmuch as hollow-horned ruminants have horns in both sexes, while antlered ruminants are invariably males. Judge Caton has studied the process of shedding the horns carefully and I can do no less than copy quite fully his statements:

"Although, as before shown, both male and female antelopes have horns, we can only distinctly detect even the rudiments of the horns on the male at the time of its birth. It may then be felt as a slight protuberance on the skull. This rapidly increases in size, and when about four months old the horn breaks through the skin, and a horny knob appears. At this time it is not firmly set upon the core, which as yet is but rudi-

mentary, and the little horn may be moved about appreciably. After this the core grows pretty rapidly and soon fixes the horn more firmly in its position. On an early kid, in my grounds, this little horn matured and was cast off on the 2d day of January, when I found it quite thrown off the core and suspended by a slight fibre on one side, so I saved it. The next day I found the other horn in the same condition, which I likewise saved. At this time the horn was fully one inch long."

"The new horn had already commenced its growth, and the tip was already hardened into perfect horn, and was extended appreciably above the core, which at that time was less than nine lines long. The new horns grew very rapidly through the winter, so that in six weeks the cores had more than doubled in length, and the horns were extended more than an inch above the cores, and the hardened perfected horns had extended down to near the top of the cores."

"But this process is better observed on the adult males. This law seems to govern the times of shedding of the antelope, —the older the animal, the earlier the horn matures, and the sooner it is cast. On old bucks the horn is shed in October, while on the early kids it is shed in January, and still later on later kids, or else it is carried over till the next year. On a late kid in my grounds on the first of December, the horn was not more than a quarter of an inch above the skin. It grew slowly all winter, and till the time of its death in May following."

"Let us observe the horn of the adult male antelope, which is shed in October. If we make our examination so soon as the horn is cast off, we can readily understand the process by which it is removed. By looking into the cavity of the cast-off horn, we shall see that it extends but about half way its length, or a little way above the prong ; and we shall also see that it contains a large number of coarse lightish colored hairs, all of which are firmly attached to the horn, and many of them, towards the lower part, passing quite through it. We see the core of the horn is covered with the same kind of hairs as those seen in the cavity of the horn. We now appreciate that these hairs grew from the skin, and more or less penetrated the shell or horn, and when this was removed some were torn from the skin and others from the horn."

"We observe, further, that the new horn had commenced its growth a considerable time before the old one was cast, for the

new horn was extended several inches above the top of the core, nearly in a vertical direction, although with a slightly posterior inclination. The top of this, for nearly half an inch, is already hardened into perfect horn. Below this it is softer, and a little way down it has lost its horny texture, but is a pretty firm and somewhat flexible mass down to the core and around it, at the upper part of which, however, it has rather the appearance of a thick massive skin, of a high temperature, showing great activity in the blood-vessels permeating it. As we pass lower down, the skin is thinner, and shows less excitement or activity. Upon this skin enveloping the core, we find the hairs already described."

"This was the condition of the new development when the old horn was cast off. It shows that the new horn had al ready made considerable upward growth from the top of the core, which only extended up into the old horn a little distance above the snag, or about half its length ; all above this, of the old horn, was solid; and was not intersected by the hairs as it was below."

"Now it is perfectly manifest that as the horn was extended in length above the core, it must have carried with it the old horn which it detached from the core and tearing out the hairs the roots of which were in the skin, and many of which extended into or through the old horn. * * * I have never observed the animal to assist this process by rubbing its horns against convenient objects, but my opportunities have not been such as to authorize the statement that they do not sometimes do so."

"When the old horn was cast off, the new one, as we have already seen, had made a considerable growth above the core, which was already tipped with perfect horn." * * *

"By the latter part of winter, on the adult, the horn has attained about this stage of growth. From this it presses on, hardening in its downward growth till the latter part of summer, or the commencement of the rut, by which time the growth is protected down to the base, and is a complete weapon for warfare, and it so continues during the rut, and until the growth of the new horn is commenced and loosens the old one from its core, and raises it from its seat as has been described."—*The Antelope and Deer of America.* J. D. Caton.

It is unecessary to add that the horn core is true bone, clothed with its periost, and this part of the horn is as permanent as in other hollow-horned ruminants. The cutaneous

layers, the transformation of which produces the horney portion, lies directly upon the periost of the core. The hairs which cover the skin, enveloping the core before horn is formed persist, and thus, according to Prof. Curtis, assist in tying down the horny shell. Upon the way in which the epidermis is altered to form horn, I may again be permitted to quote from Caton's excellent work: "Now, the peculiarity about this is, not that the epidermis is the source of the horn, or is converted into horn, but that a very limited section should be stimulated to extraordinary activity till its work is accomplished, and then subsides into a comparatively dormant state; and then another portion wakens to the same vigorous action, to be again succeeded by another active section still lower down; this state of activity, commencing at the top of the core and gradually passing along down it, followed by the perfected horn, and the quiet condition of the epidermis lining its cavity; and that this extraordinary phenomenon should occur annually."

Having thus fully discussed the horns, it remains to mention the other prominent and interesting appendages, the hoofs. The Prong-horn is one of the few ruminants which externally are bi-digitate. This may be taken as an indication of extreme development in an old type, and expresses the greatest extreme of reduction in the artiodactyle series, as the horse does in the perissodactyle. The hoofs are similarly shaped on both feet, and are very acute and narrow. The external margin is somewhat concave.

The tail is short, measuring little more than three inches.

The hair is coarse, somewhat crinkled, stiff and quite brittle. It shows no tendency to felt or mat, but bristles coarsely and usually rather raggedly over the body. There is little or no under fur in summer, but according to Caton this is present in considerable quantities in the colder season. The neck is clothed with a stiff bushy mane, of which the hairs may be four inches long. The brittle character of the pelage unfits the fur for robes, but although weak, the skin is said to rival chamois skin for like purposes.

The color seems to be very uniform, the variations being chiefly such as are incident to exposure and slight seasonal modification. The colors are bright and striking, and so well marked that they are easily recognized, as may be seen by comparing the subjoined rude sketch by an Indian with our plate. The prevailing color is rufous yellow to tawny. The face is

brown. The lower surface is white broken by two bands of yellowish upon the neck. There is also a conspicuous white spot upon the rump.

The antelope is essentially a prairie animal, and sedulously avoids the timber. Its companions are the coyotes and the prairie hare, as well as its more nearly related fellow, the buffalo. Like the last, it is gregarious, and like the first, extremely fleet of foot; indeed, it is said to surpass all other native mammals in fleetness, yet is comparatively short of wind. It seems to be well settled from observations by Dr. Canfield, that in an entirely natural state the antelope is eminently gregarious. He says: "From the first of September to the first of March antelopes meet in bands, the bucks, does and kids, all together. At the end of that time the does separate themselves from the band, one by one, to drop their kids; they produce two at a birth. After a little time the does collect together with their young, probably for mutual protection against coyotes, the old bucks in the meantime go off alone, each by himself, or at most two together, leaving the young bucks and young does together in small bands. * * * Any particular band of antelopes does not leave the locality where they grow up, and never range more than a few miles in different directions."

The males are said to be very belligerent during the rutting season and the female is credited with much courage and address in protecting her young from the coyote and other foes. Males are said to be exceedingly salacious.

The antelope is said to possess unusual powers of expressing emotions, as will be gathered from the following passage from the much quoted volume of Judge Caton:

"I had placed him in a close cage in the evening, intending to familiarize him with my presence, and divest him of his fears when he saw me by convincing him that I would not hurt him. When I approached him the next morning he seemed struck with terror and made frantic efforts to break out, which he soon found was impossible. His great black eyes glistened in affright. I spoke softly and kindly while he stood trembling as I introduced my hand and placed it on his shoulder. Despair now seemed to possess him, and he dropped on to his knees, bowed his head and burst into a copious flood of tears, which coursed down his cheeks and wet the floor."

The long white hair of the rump is said to bristle under excitement.

The American antelope is accredited with unusual intelligence and is quite readily tamed, but domestication is not permanently successful for even under the most favorable circumstances the contrast to the active and free life of the plains is very great and becomes intolerable. Health is impaired and the animal soon dies. The reproductive powers are affected even sooner than the general health and breeding in confinement is rarely or never successful. It is interesting to notice the fact stated by Caton that the prong-buck seems to consider the antelope of Asia as more congenial than native deer with which it probably was familiar in its natural state. The antelope is a dainty feeder but avoids the browse which constitutes so large a part of the food of deer and woodland ruminants. They seem to live almost entirely upon the buffalo grass of their native plains, but readily partake of the ordinary cereals in confinement.

The antelope is assiduously pursued both by Indians and white hunters for, though somewhat dry, the flesh is highly esteemed and even finds its way in considerable quantities into Minneapolis markets. The chase is difficult but is rendered less so by the curiosity which is so marked a peculiarity of the animal as to be a real weakness. Another point which is availed of by the hunter is the entire inability of the antelope to spring over high vertical obstacles, and this in spite of really marvelous powers in horizontal leaps. It would seem that long confinement to the plains has deprived them of their natural endowment in this direction. The Indians formerly availed themselves of this peculiarity by forming large low enclosures of brush-wood into which the antelope were driven, much as the caribou is captured in the north, and followed until exhausted and slaughtered. The Indians of the present day sometimes run them down on horseback, for, although fleet of foot, the antelope is said to lack wind. Staking is the usual method of hunting as their sight is but moderately discriminating. The habitat is limited to the temperate parts of North America west of the Mississippi river. Formerly their range included all of the territory between the tropics and about fifty-four north latitude and from the Mississippi to the coast except in the wooded and mountainous portions. At the present time they are restricted to the less accessible and arid regions between the Missouri river and the Mountains and southward. Southwestern Minnesota once furnished them congenial pasturage, but they have long since retired beyond the Missouri.

Fig. 22.—Personal totem of Running Antelope, drawn by himself.—Mullery's sign language, p. 410.

Fig. 23.—Cedar burial post or adjedatig of Wabojeeg, showing that he belonged to the deer clan.—Schoolcraft's History American Tribes, p. 356.

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